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Frontispeice

J. Mynde ſcul.

A View of S^t. Vincents Rock's and the Hot-Well near Briſtol.

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OBSERVATIONS

ON THE

EARTHS, ROCKS,

STONES and MINERALS,

For ſome Miles about *BRISTOL*,

AND ON THE

NATURE of the HOT-WELL,

AND THE

VIRTUES of its WATER.

By Mr. *OWEN*.

LONDON:

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the *Golden-Ball* in St. *Paul's* Church-yard.
MDCCLIV.

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THE
DEDICATION.

TO THE
RIGHT HONOURABLE
The Earl of MACCLESFIELD.

MY LORD,

I AM ſo very little acquainted with the conſtruction of a book, that I am afraid I ſhall, as they ſay, ſtumble at the threſhold. However, I beg of your Lordſhip, whatſoever this addreſs may want in form and elegance, to receive it as a moſt true teſtimony of reſpect.

BEING the leaſt of all men qualified to diſplay my talents as a writer, I have, in the following treatiſe, ſtuck cloſe to facts. It is a little part, my Lord, of the great volume of nature; the characters are very plain and very beautiful in her boſom, and all I pretend is to deſcribe them truly.

The occaſion of my writing, my Lord, was, that I ſaw many wonderful things overlook'd by moſt other perſons; and as I thought, and ſtill think, not rightly underſtood by any. I put down my thoughts concerning them, my Lord, when I was upon the ſpot; and ſince I have return'd to *London*, having had the opportunity of communicating them to ſeveral learned and ingenious perſons, and of hearing their ſentiments upon them, they are, together with thoſe obſervations, ſwell'd into a book; a little one indeed, but I hope not without matter.

As I am not deſirous of claiming any praiſe that does not belong to me, I very freely acknowledge, that whatſoever there is of the learned kind in the following pages, I owe to thoſe gentlemens converſation, the which I put down in writing when they were gone, adapting it to the parts of the work of which we had been ſpeaking. I hope I have done this in a ſatisfactory manner; I am ſure I have done it faithfully.

As to the obſervations themſelves, my Lord, which make the foundation and the body of the book, they are truly my own. I am told they differ, in many reſpects, from thoſe of all other perſons; but I aſſure myſelf that for this your Lordſhip will not think amiſs of them, except they alſo depart from reaſon: they are founded upon facts, which no one can conteſt; and I am ſure they are put down with truth. For ſuch as might be inclined to queſtion the facts themſelves, and alſo for the ſatisfaction of thoſe who deſire farther to enquire into their nature, I have left ſeveral of the things to be ſeen publickly *.

Such as the book is, I moſt humbly beg your Lordſhip's acceptance of it;

---

* At *Sam*'s Coffee-houſe, *Ludgate-Street.*

and if it ſhould appear worthy of your approbation, I know that of the world will follow.

I BEG permiſſion to conclude, my Lord, with teſtifying the true reſpect I entertain for that learned and honourable body over which you preſide, and to which all enquiries of this nature I know are moſt agreeable. I hope they will long flouriſh, and your Lordſhip long be at their head, which I take to be no ſmall aſſurance of their proſperity.

I am, MY LORD,

With the moſt unfeigned Reſpect,

Your LORDSHIP'S

Moſt obedient, and

Moſt humble Servant,

Pater-noſter-row,
March 12, 1754.

EDWARD OWEN.

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THE

INTRODUCTION.

GIVING SOME

Account of the WORK.

MY deſign in this treatiſe is to lay before the candid and ingenuous, a number of obſervations I made while at *Clifton* near *Briſtol*, and on ſeveral excurſions round about that place; not with an intent to oſtentation, but with hope they may be entertaining, and in ſome degree uſeful.

It is very likely they may differ conſiderably from thoſe which have been publiſhed by others, for I am ſenſible that it is one thing to write upon the ſpot, and another in the cloſet: however, if the latter have the advantage in point of regularity and ſhew, the former are likely to be more particular and exact; and though not ornamented, they contain the real value. Theſe rough obſervations may be compared to the ſtone taken rough out of the earth, and the others to that poliſhed by the lapidary; but what this laſt gains in neatneſs, it loſes in weight.

I make no pretence to a critical knowledge of theſe things, for they lie quite out of the way of my road of life and buſineſs; but nature is very wonderful. It was impoſſible for a man, in any degree curious, to have ſeen them without pleaſure, and I have endeavoured to communicate this pleaſure to others. I hope they will underſtand and receive it as I mean. A perſon who had ſtudied words and names, might have expreſſed himſelf upon this occaſion with a multitude of terms, but they would not have made the matter at all plainer to the generality of readers. A man may deſcribe a rock, who never read Dr. *Burnet*; and the Shape of a maſs of ſpar may be underſtood by him, who never got by heart the long names of *Linnæus.* It does not require learning but obſervation to ſay, how the beds of earth lie in this cliff; in what manner the rocks riſe on yonder hill; or how the glittering cryſtals are diſpoſed in the crevices of that ſtone. Theſe are the principal things I have taken upon me to ſpeak of, and the conjectures I have made are founded upon obſervations. They are ſuch as plain reaſon dictated, and I give them but as opinions: when they are heard, others may, as they pleaſe, receive or reject them.

It is very probable too, that theſe conjectures may differ from thoſe delivered by other writers, for I am ready to confeſs, that I have read few of them.

I have converſed more upon theſe ſubjects ſince the writing my original thoughts, than I had ever done or thought to do before, and I ſhall add the reſult of ſuch communications to thoſe parts of the work to which they refer, ſo far as I think them material. This ſeems to me to have been a ſhort way of coming at the ſubſtance of many volumes.

I have many times ſmiled to hear my learned friends ſay, in this, Mr. *Owen*, you diſagree with Dr. *Woodward*'s ſyſtem of the deluge, and in that you confirm Mr. *Tournefort*'s hypotheſis of the growth of ſtone: it is very likely, but I have read neither. I profeſs to give not a collection of the thoughts of other people, but a detail of my own obſervations; as ſuch the reader is deſired to accept of them, and of one thing he may be ſure, they are true. If any part of thoſe which regard the ſeveral kinds of ſtones be ſuſpected of miſtake, (for the ſingularity of their nature may in ſome places lead perſons to ſuch a ſuſpicion) the proofs are at hand. I have brought the things themſelves up with me, and they ſpeak more plainly than all I can write about them.

* * *

OBSERVATIONS
On the EARTHS, ROCKS, STONES, and MINERALS, about *Briſtol, &c.*

BOOK the FIRST.
Containing an account of the general ſtate of the country, the ROCKS, DOWNS, MINERALS, and EARTHS.

CHAPTER the FIRST.
Of the general face of the country, and ſoil and contents of the valleys and hills.

THE river *Avon* in this place divides the counties of *Glouceſter* and *Somerſet*, but it makes no change in the nature of the ſoil, or face of the country. On each ſide there are hills, and they are more beautiful in proſpect, than uſeful to the poſſeſſor. They are neither fertile in herbage, nor fit for the raiſing of timber. They are in great part covered with fern and furze buſhes, in the manner of our waſte land in other places. The graſs is ſhort, and the few trees that there are ſcattered about upon them, eſpecially upon *Leigh Down*, do not ſeem to thrive as in better ſoils.

It is an obſervation, I am told, in all countries, that where there are mines the land is unfruitful. Doubtleſs it is in this part of *England* owing to the ſame cauſe. That there is iron in abundance is very plain to obſervation, for the earth and ſtones are tinctured red with that ore in almoſt all places, and the cracks have in them a kind of ochre, which is a ſure proof of that metal being near; and the redneſs of the water in all the ponds and ditches, after every ſhower of rain, alſo confirms this obſervation. This may be the reaſon why the hilly parts of this country are unfruitful, the veins of metals uſually running in hills; and I have heard thoſe of judgment ſay, that *England* has not been ſufficiently examined in point of its mines: probably there is lead alſo in theſe hills, and perhaps other metals.

But beſides this, it is to be obſerved, that theſe hills are in general full of rocks, that often riſe near or quite up to the ſurface; and this may be another reaſon why they are not fruitful of plants and trees.

In moſt places, where I have examined them, the upper bed of the earth is not mould, but a fat deep yellow or rediſh clay; and there lie in many places large maſſes of ſtone above the ſurface.

If the hills are not fruitful, the valleys make amends for that defect, the ſoil in theſe is rich, and in many places deep. The earth is of a rediſh colour, of the nature of what is called redland in *Northamptonſhire* and ſome other of the inland counties, ſo much valued by the farmers.

Graſs and other herbage grow on it in a very flouriſhing ſtate, and it affords large crops of corn. This country is however, for other reaſons, unfit for the raiſing corn, and they turn it into paſturage. The graziers

ers are a more conſiderable people about *Briſtol* than the farmers properly ſo called.

The reaſon of this is ſuppoſed to be, that crops of corn, though they would grow ever ſo plentifully, would be hazardous to get in, becauſe of the rains. The lofty hills which are every where about, and which on one part extend themſelves as far as *King-Road*, where the large ſhips lie that cannot come up the *Avon*, naturally cauſing more rain to fall here than in more even countries. Whether this, or whatever other cauſe at firſt occaſioned it, cuſtom prevails now, and almoſt all the lands are employed in grazing and feeding ſheep.

The *Glouceſterſhire* wheat has always born a tolerable good price at market, but they find more advantage in this uſe of their grounds; for partly by the goodneſs of the paſturage, and partly by their own ſkill and induſtry, they have made themſelves eminent, not only for fine cattle, but for the products of the milk, the butter of *Somerſetſhire*, and the cheeſe of *Glouceſterſhire*, being deſervedly famous.

Thus have they found the way to make a good account of their low grounds; and if ſome perſons of proper ſkill and judgment were employed to examine the entrails of their hills, it is probable they would be found far from the leaſt valuable part of the country. There is no doubt of their containing minerals of value beſide the iron ores. There is in great abundance calamine, the ſtone with which they make copper into braſs, and very likely there is many a rich vein of lead neglected. There wants only a proper enquiry into theſe matters, probably to make *Glouceſterſhire* one of the richeſt counties in *Great Britain*; and ſome of the moſt barren parts of the hills would, in all likelyhood, prove the moſt valuable ſpots about it.

CHAPTER the SECOND.

A deſcription of King-Road *and the* Lower Avon, *and of the nature of the ſtones on the adjoining Downs.*

KIng-Road is about ten miles by land from *Briſtol*, and the *Lower Avon* empties itſelf into it: theſe afford a proſpect very different from the land view laſt deſcribed, but in their way very ſingular and full of beauty.

King-Road is a vaſt ſheet of ſalt water, or an arm of the ſea, ſeparating *England* from *Wales*; it is three miles over at the new paſſage into *Wales*, but its breadth is irregular. This place is ſo very pleaſant in ſummer time, that moſt of the nobility and gentry, who frequent the Hot-well, go once to view it; where the gentlemen and ladies divert themſelves upon a noble ſea beach, in picking up ſmall pebbles of all ſhapes and colours, many of which are ſo cover'd with particles of mundick, and others with thoſe of iſinglaſs, that they ſeem full of gold and ſilver, and make a very beautiful appearance when the ſun ſhines upon them: and as the paſſage is ſeldom an hour, and the expence only fourpence for a man, and eightpence for a horſe, ſeveral perſons, merely out of a frolick, take a trip over in the paſſage boat. Into this bed of ſalt water, which is the upper part of *Briſtol* channel, the rivers *Severn* and *Wye* empty themſelves.

The *Lower Avon* is carried as it were in a deep trough for about two miles from the Hot-well near *Briſtol* towards *King-Road.* The rocks on the ſides of this channel are rough, craggy, and romantick in their appearance, almoſt beyond deſcription. Many of them are very high, and of figures groteſque and rude, but pretty beyond imagination.

The cliffs hang over in ſome places in an aſtoniſhing manner, and they are many of them, covered with little ſhrubs, tall plants, tufts of graſs, and clumps of ſhort trees, in ſuch a manner, that they appear like little hanging woods, and afford a proſpect, to which I have ſeen none equal in this kingdom.

The rocks which we ſee on the ſides of the deep channel of the *Avon*, are not confined to the ſides of that river. They are continued on each ſide a great way up into the country: in other words, a ſtring or chain of rocks is thrown along this part of the country, among which the river *Avon* in one place winds its courſe.

On the *Glouceſterſhire* ſide of the river is *Durdham Down*, and on the *Somerſetſhire* ſide is *Leigh Down*, both large and extenſive; and theſe are full of the ſame rocks. They lie at a ſmall diſtance under the ſurface, and in ſome places riſe above it, very beautifully diverſifying the ſcene.

Theſe Rocks are not of common ſtone, but promiſe ſomething valuable deeper down. Some of them, when freſh broken, ſhew a variety of colours; and all of them are full of glittering particles.

The ſtones with which the ſtreets of *London* are paved, if one view them after a ſhower, ſhew many colours; and if one examine any of them when freſh broken, they glitter and ſparkle. They are very hard, and as thoſe ſay who have moſt examined theſe things, approach to the nature of granite. Theſe rocks upon *Durdham* and *Leigh Downs* reſemble them in many reſpects; but beſide the glittering particles that are in the *London* ſtones, and which are owing, as 'tis ſaid, to pieces of a flakey matter, of the nature of talc or iſinglaſs, only of different colours, theſe rocks have particles of mundick; this, added to other obſervations, tends to the ſhewing that there are veins of ore in this part of the country; for theſe mundicks, which are ſo common in *Cornwall*, where the tin mines are, and in *Derbyſhire* and *Wales*, where there are lead mines, are ſcarce ever ſeen where there is not ſome metal near.

But what is a yet farther proof of this is, that not only the rocks, but the whole earth itſelf, about *Clifton* and the Downs, is full of this ſulphureous matter; the very duſt of the road ſhines and glitters as the ſun ſhines upon it; and if a quantity of this duſt be taken up and examined, there will be found in it, beſide ſand, and ſome ſpangles of this coloured iſinglaſs, ſeveral little ſquare pieces of mundick, and other irregular fragments of the ſame ſubſtance.

CHAPTER the THIRD.

Of the rocks on Durdham *and* Leigh Downs, *and the ores and minerals found there.*

THE largeſt rocks upon theſe Downs, and thoſe which riſe in the adjacent part of the country, are in general of the ſame nature and ſubſtance. They are compoſed of that hard matter called lime-ſtone, and which is uſed for burning into lime. They are a kind of marble, for marble would burn into lime if any body would be at the expence of it; but they are conſiderably harder than the common kinds of marble, and of a cloſer grain. They take a good poliſh, and look very beautiful.

The poliſhed chimney piece in the pump room at the Hot-well, is cut out of one of theſe rocks, and makes a very elegant appearance. There is ſome variety in the colour of them, but it is generally dark and dusky; a ſlate colour, or lead colour, with a tinge of blueiſh, is the moſt common; but there are ſome almoſt black, and they are in general ſtreaked or ſpotted with white.

On examining farther into the nature and ſubſtance of theſe rocks, there is abundant proof of what appeared from the mere ſuperficial parts of the ground, that there are veins of metal in this part of the country. Iron ore, as already obſerved, is frequent among them, and is often very rich. It is the unlucky ſituation of the country in reſpect to wood, that takes from it the advantages which might be made of this ore, for there requires a vaſt quantity of this fuel for working it; and the counties of *Glouceſter* and *Somerſet*, eſpecially hereabout, are but ill wooded. Some part of this ore is of a ſtoney nature, and other earthy; a great deal of it is of that rich kind which has the appearance of ruſty iron, and is ſo much eſteemed in the *German* mines. This would yield great quantities of the metal.

I have been told of iron found pure and perfect in the earth; but others it ſeems diſpute whether there be any ſuch thing. That there is pure gold and pure ſilver in the earth, nobody ever doubted, for the gold of the mines in *Peru* is a great part of it native; and ſilver is often found in its own form and perfect ſtate there: there is alſo copper found in many parts of *Cornwall* and in *Ireland*, in great lumps, quite pure and fit for any uſe. Why this ſhould not be the caſe with iron, as well as theſe metals, I cannot ſee; and I think they go a great deal too far, who ſay it is not only becauſe they never ſaw any. As to the lead and tin, they ſay alſo, they are never found perfect in the earth, but all they mean is, that they never ſaw any. I do not intend however to ſet down other people's opinions here, but my own, and to ſpeak nothing but what I know; and ſo far, although I think one metal may be found perfect in the earth as well as another, I muſt needs ſay, what I have ſeen, and tried, agrees with the other opinion.

I have ſeen lead ore which looked like common melted lead, but it broke to pieces under the hammer, inſtead of ſpreading out as common lead would do: and in the ſame manner, there is none of the richeſt of this iron, but what appears of a different hue from common iron when it is broken. There is ſome among the pieces I have brought up with me, that will ſtick to a loadſtone, or to a knife that has been touched with a loadſtone, but ſtill it is only here and there a few grains that will, and the whole is not at all like pure iron.

There are ſome ſquare little ſtones, of a ruſty colour alſo, which are very like pieces of common ruſted iron on the outſide, but theſe are rather mundick when they are broken. Some people I have been told have taken theſe for natural iron; and there are ſome of them found not far off *Bourdeaux* in *France*, which there is an account of in the Philoſophical Tranſactions, ſent by Mr. *Secondat*, my lord *Munteſquieu*'s brother.

Many of the lumps which we break from the large beds of iron ore that are found among theſe rocks, ſhew a great variety of colours. Moſt of them are rediſh, but there are ſome brown, a great many crimſon, and yellow; and one of the moſt particular of all is like ſpar, only yellower and heavier; it is compoſed of flakes, and is tranſparent; and has generally a quantity of red matter all about it, and this ſometimes gets in between the flakes, and makes it all look rediſh. One would not take this to be an ore but by its weight; but they ſay in *Germany* they have the ſame, and it yields thirty pounds of iron in the hundred. I have one piece of this among the things I brought up; it is not half ſo big as my fiſt, and yet it weighs above a pound and half.

There are ſome of the lumps of ore that are juſt the ſame with what they ſell in *London* under the name of emery; and others that ſtain the fingers on the outſide, and are bright when broken, gloſſy and rediſh. Theſe remind me of what our glaſsmakers uſe, and call the ſoap of glaſs, and ſome mangane ſe. There are ſome pieces alſo that are ſtreaked, and very beautiful on the outſide, riſing in little bubbles: theſe I am told are what the druggiſts call bloodſtone, and what is put in ſir *Hans Sloane*'s eye medicine: and ſeveral other curious ſorts.

Thoſe that are in general of one colour, are not throughout the ſame, for in ſome of the red ones there are veins of white, which ſeem poorer than the reſt; and in ſome of the yellow ones there are alſo greyiſh glittering veins, that look like emery, and theſe are richer than the other part.

In ſeveral lumps of the others there are alſo holes, in which there are cluſters of cryſtals and ſpars of various forms, of which I ſhall ſpeak more largely hereafter; and among the maſſes of others, there are alſo ſometimes heaps of ſpar very beautiful.

I do not ſuppoſe, that with my inexperience in theſe things, I gathered all the ſorts I might have done, and yet thoſe who underſtand minerals, having ſeen what I brought to *London*, tell me there is ſcarce any kind of iron ore that I have not got. So that this ſingle part of the kingdom contains almoſt every kind of ore of this uſeful metal. If the project that has been ſome time on foot, of melting iron from the ore with ſea coal, ſhould ever be brought to bear, I don't doubt but the neighbourhood of *Briſtol* will be one of the moſt flouriſhing places in this kingdom. It is pity ſuch things ſhould reſt in diſpute: either the ore can be worked with ſea coal, or it cannot; if it can, they have enough of that fuel at hand; and I ſhould think it worth their while to make any tryals,

als. What would be the price of one man's time, that knew ſomething of the matter, to a body of people? If the merchants of *Briſtol* would join, they might eaſily ſee whether this were to be effected; and if it can, they would enrich themſelves, and all the country.

In the ſame rocks there are alſo veins of lead ore, but they are ſmall, and the ore in general does not ſeem rich. This however is no reaſon why they ſhould not be worked, for very often the largeſt and richeſt veins make but ſlight and inconſiderable appearances when they are firſt found out.

Some parts of theſe thin veins of lead are pure, and they are intermixed with a brown ſtone, which is of the nature of the calamine that is ſo frequent on the other parts of the hills; and ſome have little cluſters of ſpars, yellowiſh or white, accompanying them, and theſe have pretty forms.

It is ſaid, that in *Derbyſhire*, where there is abundance of lead, the few veins which appear on the ſurface, or to the day, as the people concerned expreſs it, are ſmall, but that in digging they ſeldom miſs to follow them to ſomething more conſiderable. It is ſaid however, that in that country parcels of lead ore often lie looſe, and that the clay has often ſquare pieces of ore in it; but of this it muſt be confeſſed nothing appears about *Briſtol.*

Upon the whole it is very poſſible, that where there are theſe, there may be alſo other veins of ore, and perhaps better. It is exceedingly worth the while to have it thoroughly examined.

CHAPTER the FOURTH.

Of the uſeful earths that are found about Briſtol.

AFTER the ores which are found in the neighbourhood of *Briſtol*, it is neceſſary to name certain earths that might be collected to ſerve the purpoſes of ſome of the arts, and which moſt naturally come in this place, as they are found about, among, and with theſe ores.

There is a very manifeſt difference between theſe earths which are found in the veins of minerals, and amongſt the lumps of ore, and thoſe which compoſe the beds that make up the ſtructure of the earth. For theſe which are in the veins, whether they hang about the lumps of the mineral, or are in looſe pieces, are compoſed of very fine particles, and unmixed with any other materials, whereas the others are often foul and coarſe.

The principal of theſe earths that are found in this part of the country are two, and they are both of the nature of ochre. The one is red, and the other yellow. They are not compact, but of a friable or brittle nature, and often crumble to duſt in the places where they lie. They both ſtain the fingers very much when they are touched. The red is of a deep colour, between crimſon and purple, and is of a ſtrong body: the yellow is a fine gold colour, and being mixed up with oil in the common way, they prove to be good colours for painting; much better than the common ſorts.

Some may ſuppoſe, that there was no great occaſion to name theſe ſo particularly, ſuppoſing them to be the ſame with what are commonly ſold at the ſhops; but though they agree in name, they are altogether different. The reddle which comes from *Derbyſhire*, and which ſome, though it ſeems to me not very properly, call red ochre, is a coarſe earth of fattiſh ſubſtance and pale colour, not at all like this deep fine and dry ochre found in this part of the country; and as for the yellow ochre that is commonly ſold, it looks like clay, and is a common earth. The yellow of this place is quite different; it is light, duſty, and of ſo ſtrong a body by way of colour, that it ſtains every thing it touches in a ſurprizing manner. A dram of it is equal to an ounce of common ochre, beſide that it is a better colour.

There is beſide this fine purple ochre, a deep red ſort that is found in greater quantities, but is not ſo fine. And beſide the yellow one already mentioned, there is in ſome of the cracks and crevices of the yellow iron ores, a fine light ſort like meal; this may be blown away by the breath, but it ſtains more than the other, and is as fine to the touch as powder for the hair. This is of a lemon colour, pretty much like that which is called by our colourmen *French* ochre, but finer.

Whether this laſt can be got in any quantities I doubt, but ever ſo little of it might be uſeful; and if it ſhould be as fine a colour, as I think it would, the price that the face painters pay for good colours would make it worth while to try if enough could not be got for their uſe.

I am of opinion, that if natural things were more looked after, both in this and other profeſſions, they would ſucceed better than the laborious products of art, for they are more likely to ſtand and laſt. We hear the pictures of the antient painters ſpoken of as ſurpaſſing all that are made at this time, and certainly they uſed none of the modern colours of the chymiſts making. They painted with the earths as they found them, and we ſhould do well to imitate their practice.

I was at one time ſurpriſed to find theſe red and yellow ochres always about the lumps of iron ore, but I hear the moſt judicious people ſay, that they owe their origin to thoſe ores; and upon recollection 'tis very like. I remember to have often ſeen yellow ſpots upon a tin veſſel that has ſtood out in the wet, and theſe are from the ſame cauſe. What we call tin is only iron tin'd, and the wet ſoaking through the tin, and working upon the iron, produces this yellow matter, which is really ochre.

Alſo if one examines thoſe ſprings which are ſaid to be tinctured with iron, one ſees yellow mud about them, which is doubtleſs yellow ochre; and in the ſame manner the ſtones about the *New Tunbridge-Wells* at *Iſlington* are tinctured with deep yellow, which is alſo ochre.

OBSERVATIONS
On the EARTHS, ROCKS, STONES, and MINERALS, about *Briſtol, &c.*

BOOK the SECOND.

Containing accounts of the CRYSTALS and SPARS.

CHAPTER the FIRST.

Concerning the cryſtals and other like ſubſtances found about Briſtol.

BEFORE I ſay any thing about thoſe ſtones, which, being denominated from the place, it might be expected I ſhould treat of very largely, in an account of the rocks and ſtones found about *Briſtol*, I ſhall make two or three general obſervations.

There are two different ſorts of ſubſtances found in the crevices of rocks and hollows of ſtone, as alſo in other places, which, from their ſimilarity in appearance, people are apt to take to be the ſame, tho' they are perfectly diſtinct from one another.

The common people often confound theſe all together, under the name of cryſtal; but the more knowing call them by two names, *cryſtal* and *ſpar*.

Whatſoever is found in the earth, that is tranſparent, many people call cryſtal, without farther enquiry, but this is very wrong. In *Northamptonſhire* there are a ſort of tranparent ſtones of a regular ſhape, like a diamond on cards, or the quarry of a window, theſe they call *ſtaunch*, becauſe they uſe them to ſtop bleeding at the noſe. They are as ſoft as chalk; you may ſcratch them with a pin; and they fall to powder in a few minutes if they be put into the fire. I don't know that there are any of theſe ſtones in this country, but I name them to ſhew there be tranſparent ſtones that are not cryſtal.

Beſide theſe, which are leſs common, there are, as I ſaid before, two ſubſtances found in the cavities of rocks, which reſemble one another. They are both clear and tranſparent, and both are found in angulated forms. Both grow alſo uſually at one end to the ſtone, and are pointed or ſharp at the other; and they commonly grow in cluſters together.

As they agree in ſo many particulars, it was very natural for people, who did not examine deeply, to ſuppoſe they agreed in all. They are therefore called in general by the ſame name; but when they are examined a little more nearly, they are found to differ in ſeveral particulars.

Some are very clear, bright and hard; and others are muddy, ſofter and leſs gloſſy. The firſt of theſe are cryſtals, the others are ſpars. They do not differ only in their external aſpect, but they are alſo of very different natures. The clear and bright ones, which are properly cryſtals, will cut glaſs: and, when put into the fire, they ſuffer no change, unleſs the heat be very violent; and in that caſe they are changed into glaſs.

The others, which are called ſpars, are ſoft and will not hurt glaſs, at leaſt only while the points laſt, which break off immediately, and while they are preſſed very regularly, and when theſe are put into the fire, they preſently calcine to lime.

Theſe are the real diſtinctions of the cryſtals and ſpars. They may be known at ſight by a judicious eye, but they will always diſcloſe themſelves on this tryal. To this it may be added, that the cryſtals are almoſt always uncouloured, and that the ſpars are often yellowiſh or whitiſh.

There is this farther ſimilitude alſo between the two things, that as they will each of them take the form of angular pyramids or columns, ſo they will alſo ſometimes form themſelves in large ſhapeleſs maſſes, the cryſtals like pebbles, and the ſpar in various irregular lumps.

CHAPTER the SECOND.

Concerning thoſe cryſtals which are called Briſtol *ſtones.*

NOW that I have diſtinguiſhed what are the two ſubſtances reſembling one another in external appearance, though different in reality, under the names of cryſtal and ſpar, it may be proper to obſerve, that thoſe called *Briſtol* ſtones are all of the former kind. There are ſpars in the neighbourhood; and I have brought up ſeveral which have the forms and figure of cryſtal, but they are never called *Briſtol* ſtones; they want the luſtre and clearneſs, and are diſregarded. Of thoſe I ſhall ſpeak hereafter.

The *Briſtol* ſtones are moſtly either perfectly clear and colourleſs, or elſe they are a little whitiſh, but of theſe laſt there are few. Some are of other colours, but they are faint, and ſeem accidental. They are naturally as well poliſhed, as if they came from the hands of the lapidary; and many of them ſeem fit to be ſet in rings without farther trouble, except that of ſeparating them one from another.

They are found in vaſt quantities in the cracks of rocks and cavities of ſtones, but chiefly in the cavities of iron ore. The common people dig into the beds of iron ore for them, and ſell moſt of them for the embelliſhing of grottos, and the like purpoſes, for which they ſerve admirably, their forms being very pretty, and their poliſh laſting for ever.

They riſe in a great variety of forms in different places, and the cluſters of them are yet more various in their appearance. About *Clifton* they reſemble table diamonds; and ſome of them, where the pyramids ſtand upright, and are broad and ſhort, have at firſt view an aſpect of roſe diamonds. They have moſtly the appearance of the table diamond when they lie ſideways, and the columns are more ſeen than the pyramids. In ſome parts about *Clifton* alſo, they are very ſmall, ſhort and numerous, and in theſe cluſters the angles are ſo frequent, and the light ſo variouſly reflected, that they have the appearance of cluſters of ſmall brilliants ſet in ſome large piece of work by a jeweller.

Theſe are the moſt elegant parcels of them, and I don't know I ever ſaw more beauty in the fineſt works of art than is in theſe, when the light falls properly upon them.

About *King's Weſton* the cluſters riſe higher, and are more irregular, the ſmall ſhoots being ſo blended one with another, that the particular form of each part is loſt; but the appearance of the whole is ſtill vaſtly romantick and pretty. Several of theſe that I brought to town are of the moſt ſtrange figures that can be conceived, ſome ſhoot up in form of the hinder teeth of a calf, and others like the ſpires and turrets of old cathedrals, and the ornaments of gothick buildings.

Beſide the different ſlight tinge that many of theſe cryſtals have, there are ſeveral that ſeem flaw'd or blemiſhed. In ſome we ſee as it were little hairs; in others white ſpecks; in many bubbles of air; and in ſome, drops of water. All theſe have been let in at the formation of the ſtone, and are never to be got out but by breaking and deſtroying it: but they greatly impair thoſe pieces in which they are found.

Thoſe pieces which are pure and clear, as well thoſe which are colourleſs, as ſuch as are ſlightly tinged, are exceedingly hard, and will bear to be kept red hot in a ſtrong fire a great while without altering their nature, or ſuffering any harm; but thoſe which have theſe imperfections juſt mentioned, will not bear this tryal. They either crack or turn white in the fire, and are eaſily broke when they are taken out.

The moſt beautiful of theſe are ſuch as are moſt diſtinct in their growth, and have their forms the moſt eaſily traced. And notwithſtanding the almoſt infinite variety that appears in them as they lie together, when they are thus examined, there are found only three figures among them all.

I have mentioned before, that 'tis the nature of theſe ſtones to adhere to the rock or ore at one end, and to terminate in a point at the other, but this is not quite univerſal. Some lie flat and grow to the ſtone by one ſide, and theſe are pointed at both ends; but of theſe laſt there are very few. It is not one in fifty thouſand that is ſo, and ſuch as are, uſually are ſmall, and require a nice eye to diſtinguiſh them.

This is one of the three general ſorts of cryſtals as I have found in this country, and this differs eſſentially from both the others, but they differ from one another only in degree. They are each compoſed of a column or ſtem of ſix ſides, and terminated by a point ſhaped like a pyramid, and having ſix ſides in the ſame manner.

As to the firſt ſort; there are ſo very few of them, that they need hardly have been named, but for the curioſity. The other two only differ as the column is longer or ſhorter. In ſome it is very long, and the whole body is like a fine ſhoot of ſalt petre, but this is not common; in others it is ſhorter; and in a great many ſo ſhort, that it is ſcarce to be ſeen; and only the top or pyramid is minded.

When a man looks upon the vaſt variety of forms, and diverſity of angles, that is ſeen in one cluſter of the *Briſtol* ſtones, he would hardly think it poſſible that ſuch a variety of figures could proceed from ſo few original ſhapes; but the variety of ſhorter and longer ſtems, and the confuſed and manifold manner in which they are thrown together; together with their crouding upon one another, and intruding upon each others form, make all the difference.

Among the largeſt of theſe cryſtals, there is generally the moſt of the ſtems to be ſeen. The ſmall ones, which are very numerous, are almoſt all pyramids. Theſe ſmall ones are alſo tinged with various colours, more frequently than the larger, and are a very uſeful article in the grotto work for which they are ſo much uſed. The cluſters of larger cryſtals make the moſt ſhew by daylight, but when a candle is brought in, theſe are ſurpriſingly pretty: they reflect the light from ſo many ſurfaces, and in ſo many directions, at once, that a cluſter of them reſembles ſome piece of artificial rockwork that is covered with froſted glaſs, only theſe are beyond compariſon brighter and more beautiful.

CHAPTER the THIRD.

Of the manner in which the Briſtol *ſtones grow to the ſtones and ores.*

I Have mentioned already that theſe cryſtals all grow to ſtones, and in the cavities of ores, fixed by the bottom of the ſprig, unleſs ſome few that are faſtened ſideways. Of theſe there is great variety; and their manner of growth is as variable; and their forms ſeem, as well as their colours, in ſome degree to depend upon it.

Wherever there is a crack between the ſolid parts of a ſtone, or wherever there is a cavity in a lump of ore, theſe cryſtals are found. If the crevice be ſmall, they are alſo ſmall; if it be large, they are larger; and the largeſt and fineſt of all, are found in the great cavities of a kind of reddiſh ſtone, that is very rich in iron.

In the cracks of ſtones they grow to each ſide in cluſters; and in the ſame manner, in theſe cavities in the ores, they encruſt the whole ſurface of the cavity; and oftentimes they continue growing till their tops meet in the centre; ſo that the whole ſpace is filled up, except ſo much as is between the ſeveral ſhoots.

I have examined the ſeveral materials to which theſe cryſtals grow, and have collected together a number that ſhew a great variety; how much farther this might have been carried, I ſhall not take upon me to ſay; only this, that I ſaw one lump of iron ore, with a cavity in it like a vault or oven, into which I could with eaſe have put my whole hand; it was full of cryſtals, both bottom and ſides, the ſpungy top, through which the water drained into this cavity, through various little pin holes, being almoſt broke off: ſome of theſe cryſtals are extremely bright, and many of them full as big as common hazel nuts. I ſaw alſo numbers of other lumps of ore not ſo big, but all full of cryſtals in like manner; however, an account of theſe which follow, may ſerve to explain the growth of theſe ſtones better than any thing I can ſay beſides.

The largeſt and faireſt cluſter that I have brought to town, grows on a piece of reddiſh ſtone, ſo full of iron, that doubtleſs it is a very rich ore of that metal. This has been cracked in ſeveral places, and it has beſides ſeveral natural cavities in it, ſome big enough to have held a wallnut, others much larger.

The cracks are all filled up with cryſtals, but they are ſmall. They grow from each ſide in a compleat cruſt, and their points meet in the middle. The cavities are alſo in great part filled, and it is in the ſame manner; but they are not altogether cloſed up, for the tops of the cryſtals have not met in the middle, but leave a cavity of a fourth or fifth part of the bigneſs of the firſt.

The method of growing of the cryſtals in theſe, is juſt the ſame as in the cracks. Firſt of all there is a cruſt of coarſe whitiſh and irregular cryſtal ſpread over the whole ſurface of the cavity; and from the top of this, riſe the other cryſtals, which are pure, fine, tranſparent, and of a regular figure. Theſe laſt are what are particularly called *Briſtol* ſtones; for the cruſt or bed, on which they grow, is not ſo much regarded;

and theſe all conſiſt of a ſprig terminated by a pyramid; and as theſe ſprigs or columns are longer or ſhorter, and as they are diſpoſed more or leſs regularly, they make a different appearance. In general, the moſt beautiful pieces of all, are thoſe in which the cavity has been moderately large, and the cruſt not too thick; and the cryſtals have ſhort columns, and grow regularly, and not too much cluſtered together.

The thickneſs of the cruſt, as alſo the largeneſs of the columns, is always proportioned to the bigneſs of the cavity; in a hollow of an inch diameter, the cruſt will be of the breadth of a ſtraw, and in the large ones, half an inch or more. I have always obſerved the thickneſs of this proportioned to the ſize of the cryſtals; and it is found wherever there are cryſtals; only where they are ſmall, it is not regarded.

It is not only where there is a cavity of this roundiſh form that theſe cryſtals ſhoot out ſo fairly; often a crack will widen in ſome part, and there they will grow in the ſame manner, for all they want is room.

Of all theſe particulars there are inſtances in the one piece of red ſtone already mentioned, although in the whole it is not ſo big as a man's fiſt. The largeſt cryſtals are in the bigeſt cavity, and they are tinged very ſlightly with a purpliſh hue.

Theſe are the general forms and manners in which the cryſtals, called *Briſtol* ſtones, are found; but the variety, from the form of the cracks, and bigneſs of the cavities, makes an endleſs change in their ſhape and appearance.

On a piece of greyiſh iron ſtone, I have ſeveral of different ſizes and degrees of purity, ſome white, and others with a ſlight, but very beautiful caſt of pearly blue: and in another purple ſtone, of great hardneſs, ſome other whitiſh and pellucid ones, and among them, ſeveral ſmall ones of the fine black water of the diamond, and of a very ſurpriſing luſtre. Where the iron ore is richer, and has riſen in bubbles on the ſurface, I have vaſt cluſters of middle ſized cryſtals covering theſe; and of thoſe ſome are reddiſh on the ſurface only, and ſome throughout. The ore itſelf in theſe pieces is ſo red, that is ſtains the hands on handling it.

I have obſerved already, that in moſt caſes the ſhoots of pure cryſtal grow upon a kind of cruſt or bed of fouler cryſtal, or ſuch as is white and irregular; but in ſome inſtances there is a ſtrange variety; the cruſt is half an inch thick, and looks like allom, and the ſhoots and ſprigs do not grow immediately upon it, but there is thrown between a thin cruſt of a reddiſh ferrugineous matter of the breadth of a ſtraw, and the cryſtals grow upon that: and ſometimes there is upon this red cruſt, a ſecond béd of ſomewhat purer cryſtal, and upon that the ſhoots grow, but with a line of red between, as if it were the rudiments of another cruſt of ferrugineous matter.

Theſe appearances are very ſingular, but they will ſpeak for themſelves, for I have brought pieces of every ſort to town with me, and there is no talking againſt fact.

Theſe cryſtals, which grow upon the redeſt ores, are frequently colourleſs; and, on the contrary, thoſe which are the redeſt of all, are frequently found upon ſuch ores as have nothing of that colour. The brighteſt cluſter which I have ſeen, take the whole together, are upon a ſtone between red and grey, very rich in iron. They look rediſh when ſeen at a diſtance; but, when ſtrictly examined, they are in general colourleſs, but have certain ſtreakes and ſpots of red in different parts.

Although the greateſt part of the *Briſtol* ſtones grow in the cavities of iron ore, this is not univerſal, for they are frequently found in cracks and cavities of ſtone that has not the leaſt tincture of that or any other metal. I have brought up cluſters, as fine as moſt of the others, in the cavities of common grey lime-ſtone, broken off from whole rocks of the ſame material; but theſe are ſeldom tinged of any colour, nor are they often very long in the ſprig.

But among thoſe which have their growth upon or in irony matter, I muſt not omit to mention two very particular pieces. The one is a maſs compoſed of ſeveral beds of cryſtal, intermixed with little partitions of iron ore. The cryſtal in this is white, and the form appears at firſt ſight quite irregular, ut being examined ſtrictly, it has a general endency to the ſhape of thoſe angular tones called *ſtaunch* before mentioned: that s, each ſeparate part approaches toward the hape of a pain of glaſs in an old window, nly it is thick.

The other ſingular production is of the ature of thoſe hollow ſubſtances that lie bout the clay pits of *Harrow on the Hill*, nd the ſand pits upon *Hampſtead-Heath*, and any other places. Theſe are long or oundiſh, and of a yellowiſh colour, but ith an appearance of ruſty iron. When hey are broken, they are ſeen to be comoſed of a cruſt of irony matter; and the ollow within is filled with ſand or clay, acording to the nature of the bed in which hey lie. This piece is a part of one of hoſe irony caſes, but lying in a cryſtal ountry, inſtead of being full of ſand, its avity is cruſted round with a bed of whitiſh ryſtal; and from this riſe, as in the others, hoots of pure cryſtal, a little rediſh. This I take to be a very great curioſity. I have een nothing like it.

To conclude theſe obſervations upon the nature of the *Briſtol* cryſtals, I ſhall only add, that among the ſmalleſt there is equal beauty, although it be not ſo conſpicuous, and there is equal variety. They are more frequently coloured than the larger, and they are often better coloured; and to this is to be added, that when they are not coloured at all, they are brighter than the larger kind, many of them approaching to the appearance of real diamond ſparks.

Some of theſe little cryſtals are brown, ſome are blackiſh, and ſome are of the brighteſt red that can be conceived. Others alſo are of a very ſtrong and fine ſcarlet, but ſo deeply tinctured, that they are not tranſparent. Some are of an iron grey; and ſeveral are of a colour between grey, blue and black. Theſe are not quite tranſparent; but, in luſtre and brilliancy, they exceed all the others; and, as I think, in hardneſs.

CHAPTER the FOURTH.

Concerning the peculiar form of ſome cryſtals found about Briſtol.

ALTHOUGH all the ſtones that are properly and diſtinctively called by the name of *Briſtol* ſtones, are cryſtals; yet all the cryſtals which are found in this country, are not of the nature of thoſe which are moſt frequent, and are called *Briſtol* ſtones. I have met with ſome things of this kind that appear very particular to me, and I ſhall mention them ſeverally.

In ſearching among the lime-ſtone rocks, I have met with two ſorts of cryſtal ſubſtances, both very ſingular, and equally beautiful, the one kind ſolid, and the other hollow. The ſolid ones are a kind of little balls of the bigneſs of a large nutmeg, rarely more; and the others are likewiſe parts of round ſtones, hollow within. Theſe are ſo much larger than the others, that the ſolid ones might have been bred in their cavities; for aught I know this may have been the caſe, for I have found none of the hollow ones entire, and where the ſolid ones were, they were commonly about the ſame places.

As different as theſe ſeem in the general appearance, they have a great deal in common. They are each compoſed of an earthy or ſtoney matter, a cryſtalline cruſt or bed, and ſhoots of cryſtal; and only ſeem to differ as turned one ſide or the other outwards. The balls are the moſt ſplendid and ſhowy.

To examine one of theſe balls ſuperficially it appears a little knot of cryſtals; its ſurface is covered all over with points, and theſe are the pyramids of cryſtals, the columns of which are ſo ſhort, that they are not to be ſeen. When this ball is broken, there is found a ſmall lump of ſtone in the centre; round this ſpreads a cruſt of whitiſh and coarſe cryſtalline matter, and from the ſurface of this, in the uſual way, grow the cryſtal ſhoots.

As to the hollow pieces, they have a coat of the ſame ſtoney matter on the outſide, and within this is ſpread a covering of coarſe cryſtal, from the ſurface of which grow the ſhoots as uſual. Theſe hollow bodies therefore very much reſemble the cavities in the iron ores, only they are detached pieces.

The ſhoots of cryſtal, on the ſurface of the balls, and within the body of thoſe other maſſes, are ſometimes colourleſs, and ſometimes tinged with red or yellow: but there is another circumſtance very ſingular in theſe ſhoots, which I have not ſeen in any any others, and which at one time tempted me to believe there were other natural figures of cryſtal beſide thoſe two or three which I have mentioned.

When we view the cryſtals of any one of theſe at a diſtance, they have a very ſplendid appearance. They glitter more than any others, and the light is viſibly reflected from more angles. Upon examination it is found, that every one of theſe ſhoots is compoſed of many more.

The ſurfaces of the ſhoots of cryſtal, whether we look upon their pyramids, or the ſprigs themſelves, are always ſmooth and uniform, but in theſe they are covered with other ſmaller figures. It has been obſerved already, that the ſhoots of cryſtal often intrude upon one another; but in theſe pieces, they grow one upon the other. Every ſingle large ſhoot is covered with forty or fifty little ones, which lie flatwiſe upon it, and break in variouſly upon one another, ſo that from their ſeveral little planes, and the leſſer ſurfaces of their ſides, and the plane of the larger pyramid ſeen between, the light is ſo variouſly reflected, that it is not a wonder there is ſeen all this brightneſs when the whole maſs is expoſed to the light.

In ſome places I have found numbers of theſe little balls, not looſe, but growing one by another upon the ſurface of a ſtone; and ſometimes the pyramids of other cryſtals, in ſmall hollows of ſtones, have been ſo covered with theſe ſmaller ſhoots, that they have looked thick and like the balls, only ſmall.

Fewer of theſe globules of cryſtals are colourleſs than of any other kind. They are very frequently white as milk, ſometimes purple, often red, and ſometimes yellow. Theſe are the brighteſt and fineſt of all, and I am much miſtaken, if being cut, they would not be called very good topazes.

CHAPTER the FIFTH.

Concerning the formation of cryſtals.

I Doubt not but many have written upon the formation of cryſtals, and very likely my opinion may differ from what they all ſay, for I have not read them. What I have to offer, are not the cook'd up thoughts of ſome other, but my own, and as ſuch the candid reader is deſired to take it. Only this I ſhall ſay, that thoſe ingenious gentlemen have generally written in their cloſets, and taken their inſtances from one another; whereas I ſpeak of what I have ſeen upon the ſpot, and refer to nothing but what is in nature. If I am not miſtaken, I have heard that the old writers ſuppoſed, cryſtal was congealed from water, and I think they ſay the preſent writers deny it. This is in general what I hear from thoſe I have ſpoke with upon the ſubject; and if there is any error in ſuch parts of this work as refers to writers, they are to be blamed who have given me wrong information. I build nothing upon what they have ſaid, nor have opportunities or abilities to ſtudy them.

Whether it be from my ignorance, or what other cauſe ſoever, I am apt to believe the old people were in the right oftener than we are aware; and in this matter of the formation and growth of cryſlal, I am of their opinion.

In the firſt place, that water can congeal into ſtone, or at leaſt that it can leave ſome ſtoney matter behind it, as it drops ſlowly away from any place, I think is plain enough from what we ſee in cellars, and all other arched buildings.

In many large vaults there hang icicles of a ſtoney matter, hollow within from ſeveral parts. Theſe plainly are formed where water drops, for the water ſtill runs through their hollows; and whether the water that ſoakes through the ſtone congeals itſelf into theſe ſtoney pipes, or whether ſtoney matter ſeparates from it, and by degrees forms them, matters not; they certainly owe their riſe and growth to water dropping there, and they will continue growing as long as any does drop.

I am told, that before *Weſtminſter-Bridge* had been finiſhed half a year, there hung ſtoney pipes of this ſort from the inſides of ſeveral of the arches, and that they do ſo ſtill; and a few years ago, when the terras was repaired at *Windſor-Caſtle*, a brick vault, made only to ſupport the earth, was opened, and the workmen could not get along in it for ſtoney icicles of the ſame kind. Theſe muſt have been formed ſince the building of the vault, and that was no great time; and yet ſome of them were five feet long, and as thick as a man's anckle. There could be nothing but the dripping of water to make theſe; and whether it all congealed, or only a part of it, or ſome ſtoney matter which was in the water ſeparated from it, ſo as it does by boiling in our tea-kettles, let the water be ever ſo clear; ſtill it ſeems to me very plain that the old people had reaſon on their ſides, who ſaid cryſtal owed its riſe to water, for all theſe icicles are cryſtal, or elſe ſpar, which is next kin to it.

Now to bring theſe obſervations to the preſent purpoſe: it appears to me, that the cryſtals, called *Briſtol* ſtones, are formed in the cavities of iron ore and the cracks of ſtones, juſt in the ſame manner as thoſe ſtoney icicles; that is, from water draining through, and reſting a great while upon the ſurface; and this I ſhall explain, not by arguments, for I have no hand at them, but by the face of things on the ſpot, where theſe cryſtals are found.

There are in this country a great many beds of ſtone, and even of other materials, ſo firm, that water does not eaſily penetrate them, and many that it does not penetrate at all, the conſequence of which will be ſhewn hereafter. Now if there were *Briſtol* ſtones found in great quantities under theſe, I ſhould be for ſeeking after ſome other origin for them; but this is not the caſe, very few, if any, are found in places where the upper part of the ground is ſo compact.

In other parts, the earth, and other matter under its ſurface, is looſe and ſpungy; and one may, on breaking it a little way, or on examining it where there has been freſh digging, ſee a number of exceeding ſmall tracts and channels, through which the water makes its way in ſinking from the ſurface.

In following theſe there are always found vaſt quantities of *Briſtol* ſtones. The ſtones are crackt or cleft at ſome depth underneath, and the iron ore is full of crevices and cavities, and all theſe are full of cryſtal. What could be wiſhed more for a Proof? Here are places where the water cannot find a free paſſage, but remains on the ſurface of hard beds of matter, and under theſe there are no cryſtals; here are other places where the water can paſs freely, and where we ſee the very tracts and channels through which it has paſſed, and under theſe there are cryſtals in abundance. This is found without variation; and can any one doubt, after this, that the water is the cauſe of the cryſtals?

This water drains freely, and paſſes along, without ſtopping, through the looſe matter, and along the little channels; but when it comes to the rocks and ores, it hangs upon the ſurfaces of their cracks and cavities, and there it congeals exactly as it does in vaults and arches, or elſe it lets go this matter from it, which congeals into cryſtals, and theſe fill up the cavities in time, though at the firſt it only cruſts them over.

If any one ſhould aſk me how this matter comes to be ſo pure? I ſhall anſwer, becauſe it ſeparates from water that has been before purified and filtrated in its paſſage: and if I am aſk'd, why it congeals always in the form of a ſpring and a pyramid? I ſhall deſire the inquiſitive perſon to tell me, why ſalt petre always ſhoots into thoſe regular ſprigs; and when he has told me one, I will explain to him the other.

This I take to be the true and real formation of *Briſtol* ſtones, and, I ſuppoſe, of all other cryſtal; and the old authors were certainly in the right, who deduced its origin from water. Whether the whole ſubſtance of the water congeals into it at once, or a ſmall matter from every drop, I ſhall not take upon me to ſay.

But this is moſt certain, I have traced, as any curious perſon may do, the water from the ſurface of the earth to the beds of iron ore; I there ſaw where it entred the cavities through numbers of ſmall pin-holes; I then broke up that very ore, and found the cavities full of *Briſtol* ſtones, ſo that I am firmly perſuaded they are produced from rain-water, and that only, as no ſprings are any where near thoſe beds of ore. Neither has the water of the ſprings iſſuing from under the rocks at a diſtance, any thing of the irony taſte, as one might naturally expect, had they any communication with thoſe large beds of iron ore.

CHAPTER the SIXTH.

Concerning the colours of cryſtals.

HAVING ſpoke ſo much concerning the nature and origin of cryſtals, there remains only to ſpeak of the manner in which they obtain their colours, and then this whole matter will have been treated of; if not perfectly, at leaſt as well as I am able.

I have occaſionally mentioned, that the *Briſtol* ſtones, although generally without colour, are ſometimes tinged to various colours. Having explained the nature of their formation, if that be allowed to have been done fairly, the other will be no difficulty, for they both depend on the ſame principle.

It has been remarked, that although theſe ſtones take ſeveral colours, yet red and yellow are the moſt frequent. I deſire it may be remembered, that in a former chapter of this work, treating of the Earths found about *Briſtol*, I have named two principal kinds, a red and a yellow, both very ſtrong colours. This may give a ſuſpicion, that the two principal colours of the *Briſtol* ſtones, being alſo red and yellow, are owing to them. But this ſuſpicion may be led up almoſt to certainty.

Theſe two earths are found only among thoſe ores, in the cavities of which theſe coloured ſtones alſo are found; and I have always ſeen, without one exception, that where the red ochre was very predominant, the ſtones were red, and where the yellow ochre was predominant, they were moſtly yellow.

I am not unſenſible that it may be ſaid, the ſame power in the ore, which in this caſe gave the red or the yellow colour to the Earth, might alſo give it to the ſtones; but of this there is no proof; and, on the other hand, there is the ſtrongeſt evidence that can be from obſervation, that not only in theſe, but in all other places, the ſtones are of the colour of thoſe earths through which the water has run. They are earths of ſo light and fine a ſubſtance, as to be ſuſpended in the water, which is not the caſe of all.

In general, I look upon this to be the caſe. Where the water has made its paſſage among clay and ſand, and other the like materials, which will give no colour to water, there the cryſtals that are in the ſtones and ores below, are colourleſs, like that water out of which they are formed; but that when there have lain in the way of the water's paſſage thro' earths of the fine light kind, ſuch as theſe ochres, which we know can be contained in clear water, becauſe the clear water of iron ſprings depoſits them; then the cryſtals formed out of theſe waters are coloured accordingly.

We ſee by this inſtance of the iron waters, that yellow earth may be contained in them while they appear clear. This yellow earth may therefore be contained in that water which goes to form theſe cryſtals; and as we ſee it can ſubſide, and ſhew its colour, after a time, by ſettling; it is not ſtrange, that it ſhould alſo ſhew it in the ſlow operation of forming theſe cryſtals, nor is it a wonder they ſhould be coloured by it.

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CHAPTER the SEVENTH.

Concerning ſpar of uncertain form found about Briſtol.

UPON the beginning to ſpeak of the *Briſtol* ſtones, which are cryſtals, I found it neceſſary, (to avoid confuſion, and very frequent miſtake) to obſerve, that there was another ſubſtance, not unlike to cryſtal in appearance, but leſs bright and fine, which was called *ſpar*. This is the matter concerning which I am now to ſpeak particularly.

This ſpar is frequently about *King's Weſton*, and in ſome other parts of this country, the bed upon which the cryſtals, called *Briſtol* ſtones, form themſelves. A large and thick bed of this ſhall be found covering a layer of ſtone, or even of earth, where there are cracks or crevices, or even where it is flat in ſome places; and over this there ſhall be ſpread a coat of rediſh, earthy, or ſtoney matter; and from this ſhall grow up ſhoots of cryſtal, in great numbers of various heights, forms, and colours.

Theſe beds of ſpar, when they are not very thick, often reſemble ſo much thoſe cruſts of coarſe cryſtal, which ſpread themſelves under the ſhoots of *Briſtol* ſtones in the cavities of ores, that an unaccuſtomed eye might miſtake them for the ſame ſubſtance, but the cryſtal never grows immediately from the ſpar, as it does from that cryſtal. There it ſhoots up as if the finer kind roſe out of the ſubſtance of the coarſer; but when this bed of ſpar is the foundation,

tion, there always is a coat of rediſh matter between.

Beſide this ſpar, which ſerves for the main ſupport of the *Briſtol* ſtones in theſe caſes, there is abundance of ſpar in this country, of a ſtill coarſer kind and uncertain figure. Upon *Clifton Mount* it is dug up at the price of ſixteen pence the load, and uſed for laying on the walks of gardens. They call it, the coarſe ſtuff; it is broke to pieces for this purpoſe, and, when ſpread about and rolled, it makes a very pretty figure.

The very worſt of it, that is, the very common ſort, has ſomething of a cryſtalline appearance, but it is foul, whitiſh, or yellowiſh, and often mixed with ſtreaks of red. Theſe large maſſes of it, however, are ſeldom throughout alike, but in ſome parts finer, and in ſome places full of bright particles, which glitter when the ſun ſhines upon them, almoſt in the manner of the *Briſtol* ſtones.

The worſt quality attending this ſubſtance, is, that it decays after a certain time; it is at the beſt ſoft, and being expoſed to the ſun and air, it periſhes; as it does frequently, even in the very beds, when only the air gets admittance to it. In this caſe it ſplits and breaks away, and looſes its tranſparence and brightneſs, appearing whiter than before, and like ſome calcined matter: a very little heat alſo takes the ſame effect upon it; and, as it gets more decayed, it turns brown, and at laſt looks like rotten wood.

They alſo find coarſe and ſhapeleſs ſpar in many places. Whenever they open a new quarry for ſtone, the ſurface of the bed is commonly found covered with it; and wherever there are cracks or cavities, it has run down into them, and is often of a very conſiderable thickneſs. It is uſually yellowiſh, whitiſh, and ſometimes browniſh; but theſe ſorts are much harder and firmer than the common coarſe ſtuff.

The ſpar itſelf, as is plain from the purer pieces, is naturally clear and tranſparent like cryſtal; and it is always coarſe in proportion as it is coloured; ſo that both its foulneſs, and colour, are plainly enough owing to earthy matter that mixes among it as it gets its hardneſs; and continues always in it.

But though the tops of ſtone quarries afford abundance of this ſpar, and they, and the cracks and cavities in the ſame beds, are, I am told, in moſt countries the places where alone it is found, it is not there that the moſt of it is to be met with about *Briſtol.* They dig the greateſt quantities of it out of the earth upon the higheſt hills, where they find it of itſelf compoſing beds of two or three feet in width, and ſeveral feet deep. This ſpar is the common ſort, or coarſe ſtuff; it is generally white, as if there were chalk in it, and mixed with great numbers of glittering particles and ſtreaks of red, and looks very beautiful; though 'tis not all alike, ſome being yellowiſh, and ſome of a browniſh colour. Every one of theſe thick beds ſeems to be compoſed of a number of others laid layer upon layer, one over another; and the ſubſtance, where it is moſt pure, ſeems to be compoſed of a kind of flakes or ſpangles, ſmall, and crouded together in a very irregular manner. The coarſer parts look more duſty, and not ſo bright.

Wherever there are beds of ore alſo there are found in this country vaſt cakes of ſpar, ſome finer and ſome coarſer, and in the ſame manner great maſſes of it are generally found about quarries of ſtone, in whatever manner they lie. Theſe, like the others, are foul in different degrees, and partake more or leſs of the beforementioned colours, according to the nature of the earth that lies above, for this is the caſe with ſpar, in the ſame manner as it is with cryſtal.

Theſe maſſes of ſpar generally lie five or ſix feet from the ſurface of the earth, but in ſome places not above two or three, and there are no ſprings ever run among them, or near them.

Of all the kinds of ſpar which is of this uncertain figure, the fineſt, and moſt pure, is that which is found upon and among the ſeveral kinds of ſtone. That upon the *Bath* ſtone, in particular, is very pretty. It is of the colour of honey, and glitters very much when freſh broken; and, when held up to the light, it is conſiderably tranſparent. It is always compoſed of ſeveral beds or layers as it were covering one another, and theſe are of different degrees of fineneſs; being poliſhed, they would certainly make a pretty appearance, for they are ſpangled, and, when broke, have very much the look of ſome kinds of marble or alabaſter.

Theſe ſpars either hang down the ſides of ſmall crevices in the bed of the *Bath* ſtone, or elſe they riſe in larger cavities in form of great bubbles, one joined to another; in the laſt caſe they are the moſt beautiful.

CHAPTER the EIGHTH.

Concerning ſpars of a finer kind, which are found in ſomewhat regular lumps.

WHAT I have at preſent named, is the coarſer kind of ſubſtance that is called by the name of ſpar. There are two others which are much finer, one in large lumps, the other in ſhoots; of the firſt of theſe I ſhall ſpeak at preſent.

This ſpar, which is found in lumps, never runs into whole veins or beds as the former kind, but it is often of a conſiderable ſize. The maſſes of it are of an irregular figure, but their ſtructure is alike in all, and their luſtre moſtly alike.

The maſſes are variouſly angulated, not regularly, but as if broken. If there be any particular ſhape they affect, it is that of an irregular ſquare, ſomewhat longer than it is wide, and with the ends and ſides uneven. Some of the fineſt pieces approach towards this figure, and what is more remarkable, the ſpar naturally breaks into it, or ſomething like it, which is not at all the caſe with the other, and ſhews this to be eſſentially different. When any maſs of this is ſtruck upon with an hammer, the little pieces that fall off are of this ſquariſh figure, and the whole ſeems to ſhatter rather than to be broken, for the pieces ſeem to ſeparate, and not to be forced aſunder.

This ſpar is alſo made up of plates or coats, like iſinglaſs. They are thin, and lie one upon another. Theſe are ſeen, not only upon the whole lumps, but upon theſe ſmall fragments; and they run quite thro'. They are much beſt ſeen in the large maſſes, becauſe there they are often broken, and then we ſee their thickneſs, as well as their extent, very diſtinctly.

If any one ſhould aſk me, why theſe lumps, which I ſay are compoſed of plates or fleaks, do not ſplit into them upon a blow, inſtead of breaking into theſe little ſolid pieces, as I have ſaid, it is a queſtion that at one time perplexed me very much; howſoever, upon a ſtrict examination, I found that thoſe maſſes of ſpar were compoſed of plates one way as well as another; that is, the flakes run upward as well as flatwiſe, and this never ſtrait, but always ſlanting. It is a very ſtrange thing to ſay, but it is certain in fact, that each of theſe plates of the ſpar, as thin as it may be, is made up of little ſquariſh pieces, like the whole body of the maſs, and they break as well one way as another, but only in theſe figures. The ſmalleſt piece that can be taken, if ſtruck againſt with a hammer lightly, ſo as to ſhatter, and not to cruſh it to powder, flies again into a number of the ſame ſhap'd pieces; and ſo on as far as ever I try'd it.

If one had not ſeen this double plated ſtructure, it would have been very ſtrange to conceive how a ſtone, compoſed of plates, ſhould break into ſquariſh pieces like dice; but whether I had found out the reaſon or not, I ſhould have related the fact. I do not pretend to explain every thing I have ſeen in nature, I only ſet down what I ſaw.

Although theſe maſſes of ſpar are a great deal more pure than thoſe large beds of it deſcribed in the laſt chapter, they are not altogether fine or like cryſtal. They are generally of a browniſh colour, ſometimes whitiſh, and ſometimes yellowiſh, in the manner of the others, but they are always very bright and gloſſy.

Where the larger pieces of theſe are broken, there are oftentimes found in the inner parts of them, ſome that is a great deal purer than the reſt. Sometimes pieces fall out that have no colour, and are very near as bright as cryſtal. Theſe are, ſome of them, three quarters of an inch long, and near as much broad; they adhered to the reſt originally, and made a part of the maſs; and, in breaking, they fall off in the ſame ſquariſh figure with the other parts, and look very ſhapely and beautiful.

If one of theſe pieces be laid upon a piece of paper, where there is a black line drawn with ink, it ſhews the line double; the two approaching towards one another, or keeping at a farther diſtance, according as the ſtone is turned about. This I take to be owing to the ſtructure of the ſtone, which is compoſed, as I have mentioned already, of plates running two ways, upwards and flatwiſe. No other ſubſtance in the world, that I know of, is formed in that manner, and therefore it is not a wonder no other ſhould ſhew things double.

CHAPTER the NINTH.

Concerning ſpar that forms itſelf into ſhoots like cryſtal.

I Shall now mention the laſt and the fineſt ſort of ſpar, which reſembles cryſtal ſo much, that it has many a time been taken for it; and in the ſame manner cryſtal, when it is a little foul, has been taken for this ſpar. All this however is owing to a want of ſtrict examination. The cryſtal that is ever ſo foul is hard, and the ſpar that is ever ſo fine is ſoft in compariſon to it. So that if a ſprig or ſhoot, that is ever ſo clear, calcines at once in the fire, it is ſpar; and if one be ever ſo foul, and will not calcine, it is cryſtal. For theſe are two ſubſtances altogether unlike in their qualities, however they may reſemble one another in their form; and this is the difference.

We ſee cryſtal riſing in ſhoots in ſome places with pyramids at their tops, and in others we ſee it ſmaller, and ſpread over the ſurface of the ſtone in little ſpangles, which are only the pyramids or tops without any ſprigs or columns. The ſame exactly is the caſe with ſpar: we ſee it riſe in ſome places large and diſtinct, and in others we find it ſmall, and ſpread over the ſurfaces of ſtones in the ſame way like ſpangles, or having only pyramids and no columns. It is very natural in either caſe to miſtake it for cryſtal, and I wiſh a great many, who fancy they know theſe things very well, don't do ſo.

There is one way however by which they may be diſtinguiſhed by the ſight. The ſmall ones, which are moſt frequent, are commonly whitiſh or yellowiſh, and they have not theſe colours ſo fine as the cryſtals when they are ſmall; and as for the largeſt ſprigs, when they are fineſt of all, they ſtill look weak and watry in compariſon of cryſtal, juſt as cryſtal does compared to a diamond; they have not the ſame bold ſplendor, nor the ſame full body.

There is one way very ſure to diſtinguiſh them alſo, which is this, pour a drop of aqua fortis upon the fineſt ſpar in the world, of whatſoever ſhape, and it bubbles up in a moment, and will eat it to pieces; whereas if you cover the cryſtal, let it be of what ſort it will, with the ſame liquor, it takes no more effect upon it, than if it were common water.

This is a way to know cryſtal and ſpar from one another in any form, and it is an eaſier method than by fire; and is more ſure and certain than any other.

But without having recourſe to this, there are other obſervations alſo to be made by the eye that will at any time ſhew whether a thing be cryſtal or ſpar. The ſhoots of ſpar, if ever ſo fine, have not the exact ſhape of thoſe of cryſtal. The cryſtal ſprigs here, and the little pyramids without ſprigs, in the ſame manner, have always ſix ſides, never more nor fewer. The ſpar here never have ſo many; the ſmall pyramids, which are the moſt common, and which, as they riſe in cluſters upon the ſurface of ſtone, very much reſemble the cryſtals of that kind, have never any more than three ſides; and as for the ſhoots of the larger kind, thoſe fine ones that moſt reſemble cryſtal, have only five ſides; and their pyramid is never ſo tall or ſo ſharp. This is an eſſential and certain difference.

Before I cloſe this chapter of the regular figured ſpars, there is one more ſort I muſt mention, which is very ſingular. This is frequently an inch high, and half an inch thick at the bottom. It is a ſhoot without any ſprig or column to ſupport it; and has ſomewhat like the figure of an *Egyptian* pyramid in minature, and has always five ſides.

This is commonly compoſed of a browniſh ſpar, and looks bright and fine when it is broken, but it is generally very foul on the outſide.

There is not any one kind of ſpar, that more reſembles cryſtal, in its manner of growth, than this, although the form is not like that of any cryſtal ſhoot whatever. As the cryſtals of the fineſt kinds riſe from a cruſt or bed of cryſtal of a coarſer ſort, ſo this always has its origin from a coarſe ſpar. There ſhall be a bed of ſpar of ſome depth, at the top of which this ſhall take its riſe.

If a fragment of this bed be examined, we find it uſually very coarſe low down; toward the ſurface it is whitiſh and foul, and is compoſed of irregular plates; over this white maſs there is ſpread another of a pale brown, and upon the ſurface of this, which is the uppermoſt coat of the bed, grow theſe ſhoots. They are ſo many brown pyramids ſtanding uſually a little ſlanting; and if the tops of any of them are broken off, that is always done alſo in a ſlanting manner; for the ſprigs and ſhoots of ſpar, of whatever form, in general break ſlanting.

CHAPTER the TENTH.

Concerning the formation and colouring of the various kinds of ſpar.

AS I was ſenſible that in delivering my opinion about the formation of cryſtal, I ſhould differ from what other people at this time think upon that ſubject, I am no leſs aware that my opinions concerning the origin of ſpar, will be as unlike thoſe of others; but I ſet them down, not as confirmations of any other perſon's, nor in deſigned oppoſition to them, but merely as they occurred to me; upon what foundation the reader will judge: and having given them a hearing, he is at liberty to think as he pleaſes.

In the firſt place, I am ſenſible, that it is the common opinion of mankind, that ſpar is formed by the ſtoney matter depoſited from the water of ſprings in their paſſage, either above or under ground. I am not about to contradict an opinion that has ſuch plain proofs of its truth. But I muſt beg leave to ſay, that all ſpar is not formed ſo; and this in particular about *Briſtol*, of which it is my buſineſs to ſpeak, is not at all formed that way.

I know that in many parts of *England*, there are ſprings, the water of which is ſo full of what is called ſtoney matter, that if a piece of ſtick be put into them, the ſtone ſeparates from the water, and gathers in a cruſt about the ſtick This ſtone is ſpar; and this depoſiting of a cruſt of it over the ſtick or other ſubſtance, is very improperly called petrifaction; and theſe ſprings conſequently are as improperly called petrifying ſprings; their fulleſt effect being only to encruſt: the ſtick, or other ſubſtance, never being converted into ſtone, as the vulgar think.

I have been ſhewn alſo large cakes of ſpar, compoſed of beds of various colours, which have been brought from the ſides of other ſprings abroad, where the water is ſo full of this ſpar, that it depoſits it as it runs, making walls of it all about, and blocking up the channels, if not cleared, through which itſelf ſhould flow.

I make no queſtion of theſe beds of ſpar being formed by the ſprings; for there is in a manner the teſtimony of the eye-ſight of it; but they go too far who ſuppoſe that all the ſpar in the world is formed this way. The only difference between my opinion and theirs is, that they think the water of ſprings to be the only water that is capable of congealing into ſtone, or of forming ſtone, by throwing out of itſelf parts that can ſo congeal; whereas I believe, nay I am ſure of it, that all water whatſoever is capable of forming this ſtone called ſpar, rain water itſelf not excepted.

This will appear very plainly, from an examination of the ſtate of the earth about *Briſtol*; and what I have to ſay on this head, will confirm all I have advanced before about the formation of cryſtals; for theſe two ſtones are in many reſpects like one another; and nature has ſo much ſimilitude, when things are of the ſame or a like kind, that what is ſaid of one, will always ſerve for another in the greateſt part.

That there may be ſpar in the country about *Briſtol*, formed, as it is in many other places, by the water of ſprings in their paſſage, both under ground, and on the ſurface, I do not pretend to deny, but I have ſeen none of it, though I examined the ſprings that iſſue from the rocks for that purpoſe. But here are not many opportunities of ſeeing it. When we examine the hills on which this ſpar is found in ſuch thick beds, the ſprings run under the ſolid beds of rock at two hundred feet deep, or more, and the ſpar is often found near the ſurface. Theſe ſprings therefore can have no effect in producing this ſpar, that is very certain; but it is found here in moſt ſurprizing quantities, and therefore there muſt be ſome other way of accounting for it, for 'tis plain that nature took ſome other way to make it.

As I have declared my opinion, that cryſtal owes its origin to water, or a part of water, or ſomething ſeparated from water and congealed, ſo I am convinced does ſpar. Let us examine for this purpoſe the ſurface of a quarry of ſtone, and by accounting for the production of the ſpar there, we ſhall be led to underſtand that of all the reſt, though of ever ſo different appearance.

A bed of ſolid and hard rock lies four or five feet deep, or more, below the ſurface. They dig away the earth to come at this, and the firſt thing they meet withal is generally a coat or cruſt of ſpar ſpread over the flat ſurface of the ſtone, and of the colour, or ſomething like the colour, of the earth which they have dug away. If that earth have been rediſh, as is often the caſe, the ſpar is of a rediſh or ruddy brown; if whitiſh, the ſpar looks pale; and, if yellow, the ſpar in the ſame manner is yellowiſh.

Now the queſtion is, how came the ſpar there? Not by the courſe of any ſpring, for, as I have ſaid before, there are no ſprings here but what are two hundred feet below, with ſolid beds of rock between. But if what I have ſaid about the formation of cryſtal be regarded, the ſame obſervations will explain it; as thus:

Here is a coat of looſe earth, and a bed of ſtone underneath. Rains fall upon this ground, and what muſt be the conſequence? Why it is very plain. The water will ſoak through the earth, and will, if there be any fine particles in that earth, be ſtained by them, or take ſome of them down with it. It comes to the ſurface of this bed of ſtone, and what is it there to do? It cannot ſoak through that ſo readily as it did through the earth, therefore it reſts upon it; and, by degrees, finds, one where or other, little cracks or crevices, or looſer parts in the ſtone, where ſome of it gets down, but a great deal ſtill continues lodged upon the ſurface.

I ſuppoſe this water to abound with matter capable of concreting into ſtone, as all other water does, and here it lies a long time at reſt. This is all that is required for the ſeparating of this hard matter. It is ſeparated in conſequence of the long ſtagnation, and it forms this coarſe and thick ſpar; which owes its foulneſs, as I ſuppoſe, not to any thing foul in its own nature, but to the earthy matter it had carried down along with it. And the quantities of ſpar that are found upon the higheſt hills, and down by the ſides of all the beds of ore, and quarries of ſtone, encruſted, as it were, one cake upon another, are alſo convincing proofs of ſpar's being, in this part of the country, produced from rain-water, and that only: for, as I have ſaid more than once, no ſprings whatſoever can poſſibly have any communication with it.

This I take to be the origin and formation of the ſpar: and every thing that can be remarked in the thing itſelf tends to confirm it. Where the earth has been leſs capable of fouling the water in its paſſage through it, the ſpar is cleaner; and in ſuch places we ſee it reſembling cluſters of grains of ſalt, or lumps of allom, and ſometimes the ſhoots of ſalt petre, as ctyſtal does. All this variety is owing only to the different nature of the earths through which it has paſſed, the ſubſtance of the ſpar being all the ſame, whatſoever is its form; and the coarſeſt cakes of it, and the fineſt ſprigs, equally burning to a ſort of lime in the fire, and anſwering alike upon all other tryals.

Having mentioned the ſeveral forms of ſpar, I ſhould not omit to name one other which is ſometimes met with in this country, and which is very pretty. This is always compoſed of ſmall particles, and ſpreads itſelf over the ſurface of ſtones in the manner of the ſmall pyramids of cryſtal and ſpar; but although it be really a ſpar, it is often as bright and glittering as cryſtal.

When the ſeveral cluſters of theſe are examined, they are found to be compoſed, not of pointed ſhoots or pyramids as the others, but of little ſquare pieces like dice. They are of ſeveral colours, but moſtly yellowiſh. I have never met with any of theſe, except where there were veins of lead ore. Whether the lead have any ſhare in giving them this ſquare form, I leave to others to judge.

As to the colouring of the ſeveral kinds of ſpar, I look upon it to be owing to the ſame cauſes with the colouring of cryſtal; and having already declared my ſentiments upon that head, I ſhall not repeat them in this place.

OBSERVATIONS

On the EARTHS, ROCKS, STONES, and MINERALS, about *Briſtol, &c.*

BOOK the THIRD.

Containing an account of the QUARRIES of STONE, their NATURE and USE.

CHAPTER the FIRST.

Of the manner in which the ſtone lies; its ſubſtance, and uſes.

IT is the common method of ſpeaking, when we name the quarries of ſtone in any place, to make uſe of the word beds of ſtone. I have uſed it, that I might be readily underſtood; but it is neceſſary, now I am entering more immediately upon the ſubject of the ſtone itſelf, to explain that term, otherwiſe there may be great miſunderſtandings, and what I have farther to ſay, may be often unintelligible.

By a bed of ſtone is meant flat cakes or maſſes of ſtone, running to a vaſt length and breadth, without interruption; and the pit they dig the ſtone from, is uſually called a quar or quarry, and thoſe who break it up, are called quarriers.

The ſtone in this country all grows in looſe pieces, though laid near one another. They call theſe joints. They are of various ſizes, ſome a foot ſquare, or leſs, and others four or five feet ſquare, or more than that; and they are, eſpecially the ſmall ones, removed the eaſier for this natural breaking.

But what is more ſurprizing is, that theſe rocks never riſe perpendicular, but all ſlanting, ſome one way, ſome another, none ſtrait up.

This is a fact: I have examined the matter very carefully, and find it univerſal; and ſpeaking to the quarriers, they all ſay the ſame. The rocks at the river ſide are, in ſome places, upwards of two hundred feet high, but in all this ſurface there never is to be ſeen one ſtrait upright. Nor in the earth, at a diſtance from the river, where-ever there has been opportunity of enquiring into the matter, as is the caſe in every deep pit or quarry, all the rocks riſe ſlanting the whole way from the bottom to the top, the joints riſing one above another like geometry ſtairs; only, inſtead of juſt reſting one upon another, as they do, one joint lies perhaps two thirds over the other.

The ſubſtance of theſe rocks is much the ſame with thoſe on the river ſide; it is alſo chiefly of a blueiſh, ſlate or lead colour; but it is browniſh in ſome quarries, and whiter in others, and in ſome grey.

That taken out of the cliffs by the river, is, when broken ſmall, often uſed as ballaſt for ſhips; and that dug on the Downs, and in other places, is burnt into lime.

The lime that is made out of theſe is of a beautiful colour, but, when made into mortar, that mortar is not ſo well coloured as what we have at *London*, but it is much ſuperior in its qualities. We have our lime here made of chalk, but the *Briſtol* lime, which is made out of this hard ſtone, makes a much ſtronger mortar.

They uſe theſe ſtones alſo for building houſes and walls. They encloſe all their yards and gardens with ſtone walls in this country; and, in many places, the fields are encloſed with it; and you have often a large flat ſtone to get over for a ſtile.

CHAPTER the SECOND.

Of the ſtrength and duration of the ſtone in and out of the quarry.

THE ſubject, of which I ſhall treat in this chapter, and which I ſhall have occaſion frequently to mention afterwards, having not been ſo much conſidered by others as it deſerves, I ſhall neceſſarily uſe certain terms that are not common, but the neceſſity muſt plead my excuſe.

There is great difference between that ſtone of the ſame quarry, which has been properly preſerved, and that which has been expoſed to injuries. This is the caſe with ſpar, and many other ſubſtances, as well as abſolute quarry ſtone; and accordingly, when I have occaſion to mention the ſtone, or other ſubſtance, in its natural and good condition, I ſhall call it the *healthy* ſtate of that ſtone; and, on the contrary, I ſhall call that condition, in which it has loſt its original firmneſs and ſtrength, its *decay*.

Having ſettled the meaning of two ſuch neceſſary terms, I ſhall proceed to obſerve, that although theſe rocks, as they lie in their natural ſituation, will doubtleſs retain their qualities for many generations, yet there is a time when the ſtrongeſt of them go off as it were from their original nature; that is, they loſe their colour, weight, health and ſtrength; and, as they become light, by degrees they decay and moulder away into abſolute duſt and dirt.

This appears beyond contradiction by ſeveral parcels of the ſtones which I have brought from the quarries, ſome pieces of which are heavy, hard and ſound, while others are light and ſpungy. Theſe light and ſpungy pieces were taken out of perfectly dry and deep pits, well ſecured from the injuries of the weather; the ſtone of which has all the appearance of extreme old age, having loſt all its colour, ſound, health and ſtrength.

But this is not all that is obſervable on this head: there is ſomething regular in the occaſion and manner of the decay of the joints alſo, which it may be uſeful as well as curious to ſet down.

In the firſt place it is certain, that if a whole joint be removed out of its natural place, even though its very covering is not in the leaſt injured, it will never thrive afterwards. This is a proof how much better nature provides for theſe things than we are able to do it.

It is alſo to be obſerved, for experience abundantly ſhews it, that the tops of theſe joints of ſtone are much better ſecured by nature againſt injuries than their ſides: and here alſo that univerſal proviſion made by the author of nature for all his works, is evident; for the tops, in a ſtate of nature, are very often expoſed to the weather.

On *Durdham-Down*, *Leigh-Down*, and many other parts of this country, the tops of the rocks appear in great numbers, for a vaſt way together, above the ſurface of the ground. They are expoſed in this ſituation to all the injuries of the weather, but they ſuffer no hurt by it. The whole body of thoſe large maſſes of ſtone is perfectly ſound, ſtrong and healthy; and, if taken up, and employed in building, will ſtand all weathers, and laſt for ages.

This is the ſituation in which nature may expoſe them, and in this we ſee they are defended by nature; but when the joints are expoſed ſideways, the caſe is very different. When a quarry of ſtone is once broke into, as we ſee in frequent inſtances, whenever the workmen leave off, the joints which are left in their beds, with their ſides open to the aſſaults of the weather, though when firſt left ſo, they were as ſound and ſtrong as any of the others, yet in a little time they ſplit at the ſides into thouſands of little diviſions, and ſoon after this the body of the ſtone, ſo far, moulders and decays and crumbles to dirt. About the lime-kilns on *Durdham-Down*, one can ſcarce turn any way without ſeeing this; the ſtone all round the ſides of the

the pits or quarries, of which there are a great number, appearing like rotten wood.

In the mean time, while the workmen leave theſe expoſed ſideways, there are a number of others alſo léft expoſed in the ſame manner to the air with their tops upwards, juſt as they are on the Downs, and other places naturally. Theſe are what lie in the bottom of the pit. Now while thoſe which are in the ſide of the pit decay, as I have mentioned, theſe ſuffer no change, but remain ever ſo long ſound, and are fit to be taken up at any time, by digging deeper, for the moſt important purpoſes.

It muſt be ſeen from this, that nature has, beſides the thin covering all theſe ſtones have naturally (which is like the ſkin to the fleſh of an human body, preſerving it from injuries) given ſome peculiar defence to the tops of thoſe joints, which the ſides have not; and this can only be by the cloſeneſs of the grain in thoſe parts which were often to be expoſed, and the want of that cloſeneſs in parts where the accident leſs frequently happened.

That the air is this deſtroyer is extremely plain, but the air alone does not effect the miſchief ſo ſoon as when the ſun and rain by turns come upon the joints, for this is a ſort of weting and calcining, like what the chymiſts talk of, by which they will break the texture of many very hard bodies.

We have frequent obſervation in proof of this. The ſtone pits that are about the lime-kilns on *Durdham-Down*, are altogether expoſed to the air, and the ſtone in the ſides of them decays accordingly very faſt; but in other places, where the ſides of ſtones are left open in the pits, but theſe pits themſelves are ſecured and ſheltered in ſome degree from the ſun and rain by the hills, as is the ſituation in many places, the ſtone does not decay ſo ſoon as the others that are quite expoſed, nor altogether in the ſame manner.

It is not the nature of this ſtone in particular that expoſes it to decay by the weather, for we ſee it uſed in building, and there it ſtands the weather as well as any other, and will laſt for many ages: there is indeed very little ſtone in *England* ſtronger.

The effect of the air, in length of time, upon ſtone, as well as upon every thing elſe, is well known. If we look at the antient part of *Weſtminſter-Abbey*, we ſee the ſtones in the ornaments mouldering away without any other cauſe; nay, it is ſaid, that even glaſs will be brought to duſt by the ſame power; and the windows in that, and other buildings, ſeem to confirm it, many of the panes being eaten into in ſeveral places, and having, in a great degree, loſt their tranſparence; but this is the effect of extremely long time, and is not what I ſpeak of with regard to the ſtones of theſe quarries.

But before I finiſh this chapter, I muſt juſt mention another thing which I look upon as very ſingular in this ſtone. Where ponds are pitched with it, as is very common about *Clifton*, it will hold water, and laſt for many years; here it is expoſed to the water and air, out of its natural bed. But where it lies three or four feet under ground, in its natural bed, and the water is continually draining to it, and lodging upon it in too great quantities, as it frequently does upon ſuch parts of the beds of ſtone as lie low, for want of a free paſſage to the ſprings that run under the rocks, it abſolutely chills and periſhes it. This is a fact; and it is as ſingular and as ſurprizing as the decaying of the ſides of the joints in their natural beds, which would have laſted for ages, had they been taken up and uſed in building. I examined and found inſtances of it in ſeveral places. Wherever I found the ſtone quite ſoaked through in the earth; that is, when it always continued wet in its natural bed, it had loſt its bright lively colour; its ring or ſound was gone; its health and ſtrength greatly impaired; it had a pale deadiſh look; and was, for the moſt part, gone or going off apace.

CHAPTER the THIRD.

Of the manner of digging the Stone, and blowing up the rocks.

THE ſtone of this country comes very cheap to thoſe who have occaſion for it. Nature ſeems to have given the rocks and quarries as a common benefit, and no one with-holds them. The people who live in the neighbourhood are permitted to take what they pleaſe of it, ſo that they have no expence but the digging and the carriage. For the firſt purpoſe, there are people who make it their trade, and are called quarriers. They dig it from the pits at four-pence a load. As to the carriage, 'tis alſo cheap enough, though proportioned to the diſtance.

The quarriers, according to the places where they work, uſe different means. When they dig it upon the hills, they work in the common manner with pick axes, iron crows, and large hammers; and there is no great difficulty, as it grows in joints, in looſening and breaking it up, though even that is hard work when cloſely followed. But in the working at that of the high rocks by the river ſide, they do it in a different manner, and are paid a different price. They work here by blowing them up, for which they are allowed ſix-pence or ſeven-pence a ton, the maſter of them always finding tools and gunpowder.

The method of this work is very ſimple and eaſy, and yet it is very effectual. Two people uſually ſet about it at a time; one of them has in his hand the boring tool: this is an iron bar, formed at the point into a kind of chiſſel: the other has nothing but a hammer.

The perſon who manages the boring inſtrument, takes firſt one of about two feet long, the point of which he fixes upon ſuch part of the rock as he thinks will beſt ſuit his purpoſe; and the other ſtrikes upon the top of it with the hammer, while he holds it ſteady. The blows are repeated; and the bar being turned every time the perſon ſtrikes, and being quite round, except at the point, it makes its way into the ſtone.

When a little hole is made, they put in water; and as they go on boring, they from time to time clean out the hole in the manner as people clean a gun-barrel. The bar of iron is about three inches in circumference, and by this manner of working it, a hole is made of its bigneſs, and of a depth equal to its length. They then take a longer bar, and ſo on to their longeſt of ſix feet, if the nature of the rock they are at work upon requires it; the depth of the hole being always in proportion to the quantity of ſtone they think to remove.

When the hole is thus made of the depth they chuſe, they clean it very well out, and make it dry. They then put in a quantity of gunpowder, in proportion to the hole they have made, ſometimes not more than half a pound, and ſometimes two or three pounds. When the powder is in, they thruſt down a ſmall wire reaching down to it, and up to the ſurface. They then make up ſome very ſtiff clay, or other ſuch matter, and ram it into the hole extremely firm, filling it entirely, and in the ſtrongeſt manner poſſible. When the clay or other matter is well in, they draw out the wire, this leaves a little hole quite down to the powder at the bottom. Then then fill up this hole alſo with powder, and lay a train of gunpowder from this. At the end of the train they lay a piece of lighted touch-wood, and leave it to take effect.

It is their buſineſs to get away, for the effect is very violent. Several tons of ſtone are generally looſened by the blaſt, and frequently pieces of two or three pounds weight are thrown like cannon-ſhot to a conſiderable diſtance.

They are not always alike ſucceſsful in theſe blows, as they call them, for though they ſometimes looſen many more tons at a blow than they expected, yet they as often miſcarry.

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CHAPTER the FOURTH.

Concerning the effect of that coat which covers ſtones in and out of the earth, and its nature.

I Have obſerved, that all the ſtone in this part of the country riſes in joints, and that theſe decay at their ſides; their thin coats or coverings not being ſufficient to ſecure them from the air, ſun and rain, while they lie expoſed in their natural beds. I am very ſenſible that moſt of the obſervations contained in this treatiſe will be new; and what I have to ſay concerning theſe coats of the ſtones is one of them. The thing has been very little conſidered, nay, very few have minded it at all; but there is a great deal in it. What I have to ſay upon the matter, is like what I have delivered on every other occaſion, the reſult of my own obſervations. That what I ſay is fact may be depended upon; as to my reaſons about theſe things, whether they are right or not, others are to judge. They have a good foundation; when they have been heard, every man is to abide by them, or think otherwiſe, as he ſees beſt.

This coat upon the quarry ſtone is a thing that has not been much minded, nevertheleſs it deſerves to be well looked into. It is a thin cruſt or covering which ſurrounds the whole ſtone, and differs from the inner part a little in colour.

Moſt people ſeem to take it to be only the outſide of the ſtone, and not different from the inner, but they are miſtaken; the colour differs a little, the ſubſtance more; and there is a vaſt difference between the ſtone that has it, and the ſtone that has not.

The bark that ſurrounds the ſtalk of a plant is very thin, and is pretty nearly of the ſame colour of the ſtalk in moſt places; but it would be very fooliſh for that reaſon to ſuppoſe that the ſtalk had no bark at all, or to ſay that this was only the outer part of it.

The coat of ſtone reſembles the bark of plants in more reſpects than appearance; it is as neceſſary to their health and perfection as the other. As little a thing as this bark of the ſtalk appears to be, the plant would be in a bad way without it; it would decay and rot; and juſt ſo it is with the coat or covering of this ſtone. It is eſſential to its perfection, and the ſtone continues to thrive ſo long as this coat is upon it, and no longer.

We know that the bark of a plant is, like all the other parts of it, nouriſhed from the root, but we do not ſo well know the manner in which ſtones are ſupported; howſoever I ſhall, from experience and obſervation, give my ſentiments on this matter; and I hope convince all perſons, as I am myſelf thoroughly convinced, that this coat or bark of the ſtone may be recovered again after it is loſt.

It would have been impoſſible to have ſpoken intelligibly upon this ſubject, if I had not firſt given the account which goes before of the formation of ſpar and cryſtal; but that being underſtood, this will be more eaſy.

Perhaps the ſtone was originally formed naked in the earth, but there being not expoſed to the injuries of the air, it was in leſs danger of decay; and, at the ſame time, the means of its obtaining this defenſive coat were about the quarry.

We know that all places, where there are ſtone quarries, have moiſture in them. The rains from above penetrate and ſoak down to them, and they ſpread over the ſurface of the joints or maſſes of ſtone. Theſe maſſes, ſuppoſing them at firſt naked, muſt be rough upon the ſurface more or leſs, according to the nature of their grain; and this roughneſs would detain the water from running entirely off from them.

This water we know to be full of ſtoney matter, and ready, under the proper opportunities, to congeal or concrete into ſtone, or to ſeparate from its quantity certain parts ready to concrete or congeal. This we ſee in cryſtals and ſpars, which are found whereſoever this water reſts in ſmall quantities; but, in this caſe, it could not reſt any where, but being ſpread over the ſurface, if it in any degree congealed, it muſt do ſo univerſally, and they muſt not form a lump of cryſtals, or a cluſter of ſpars, in any one place, but cover the whole with a thin coat. This would be thickened by ſucceeding quantities of water to a certain degree, and this would make the coat we find upon theſe ſtones.

If it ſhould be anſwered, that, according to this ſyſtem, the coat ought to thicken for ever, and that we could not find it of this thinneſs; I anſwer, no. I ſuppoſe the water to have been at firſt detained upon the ſurface of the ſtone by the roughneſs of that ſurface; and by degrees that roughneſs would be loſt. The grain of the ſtone being ſomewhat coarſe, would occaſion a roughneſs that would at firſt detain the water ſtrongly; but after the firſt coat had been depoſited upon it, this grain would be a little ſmoothed; and thus, every addition ſmoothing and levelling the ſurface more and more, after a certain time, that is, after the ſtone had acquired a coat of that little thickneſs which we ſee, the water would no longer remain, or be detained upon it, and ſo no more addition could be made to it. So long as the water was held upon the ſurface by its inequalities, ſo long ſomething was depoſited from that water to make a coat or covering; but when, from the ſmoothneſs of that coat, the water did not hang upon it any longer, no more thickneſs could be added to it from the water. Thus the water, which at one time remained about it, and then formed its concretions, afterwards ran down its ſides, and fell into its natural cavities, where it was detained, and there formed thoſe cluſters of cryſtals and ſpars, which we find in thoſe cavities and crevices.

CHAPTER the FIFTH.

Concerning the recovery of this coat of ſtone, when they have loſt it.

I Muſt be frequently repeating my ſenſe of the novelty of my opinions, ſince I am convinced, by the converſation of ingenious perſons, that they differ in a great degree from what have been eſtabliſhed by others. I find I am here again entring upon a ſubject that has been often diſputed, and remains yet undetermined, but I ſhall ſay what I know, leaving it to others to determine how much that favours one ſide or the other.

The queſtion, as I find among thoſe who ſtudy theſe things, is, whether ſtones continue as they were from the creation of the world, or at leaſt from the deluge, or whether they at this time grow? As to the term that is commonly uſed, the vegetation of ſtones, I cannot think that is very proper, ſince, if they do grow or encreaſe, or receive addition,

tion, it is not in the nature of vegetables or plants, by a root, but in a quite different manner.

Doctor *Woodward*, as I am informed, is in moſt reſpects of opinion, that all the ſtones in the world continue juſt in the condition that they were at the time of the waters retiring after the general deluge; and, on the other hand, M. *Tournefort* ſuppoſes that they grow.

Dr. *Woodward* having only a negative to aſſert, namely, that they do not grow, has little need of inſtances; but M. *Tournefort* was to ſupport his opinion by proofs.

The principal that he has brought, they tell me, is from the grotto of *Antiparos*, one of the *Grecian* iſlands. There is it ſeems a deep cave into which people ſometimes deſcend; and when they do ſo, they generally cut their names and the date of the year upon the rock, as our country people do upon the leads of a church, to ſhew they have been there.

When M. *Tournefort* was down in this place, he obſerved a great many of theſe names and dates. Thoſe which were freſheſt done, were cut into the ſtone, as our engravers of tombſtones do the letters; and doubtleſs all the others had been at firſt cut in after the ſame manner; but, among the number, ſome appeared upon a level with the reſt of the ſurface, and others were raiſed above it, in a kind of emboſt work.

Now as all the letters had been originally cut in, and ſome at this time appeared filled up, and ſome raiſed, it appeared very plainly that the ſtone had in theſe places grown. This is M. *Tournefort*'s great argument.

How far what I have to ſay will favour this opinion, others may judge; however, both in this place, and in a ſucceeding chapter, I ſhall certainly advance things that will ſhew ſtones are capable of changes, and that theſe changes do actually happen to them while they lie in the earth, and even above ground in this part of the country.

The ſeveral dates to the names in the cavern mentioned by M. *Tournefort*, ſhewed, that the longer the cut had been made in the ſtone, the greater was the quantity of matter that filled it up: my obſervations will prove, that a great courſe of years is not neceſſary to ſuch an effect.

I have already ſhewn what the coat of a ſtone is; how it is acquired, and what are the conſequences of loſing it; but there remains behind the greateſt ſingularity of all, which is, the manner in which they may recover it when it has been loſt. This will be ſhewn in ſome inſtances, and I make no doubt but it will hold good equally in all.

When I examined the ground about the pits near *Redland*, I found a great number of ſtones of different ſizes, and very odd figures, lying about, the like of which I had not ſeen elſewhere. It is to be obſerved, that in this part of the country, there are no pebbles, nor ſmall ſtones of any kind, except pieces broken off from the rocks, and this made the preſent appearance the more ſingular. I examined ſeveral of them, and found them entire, perfect and healthy ſtones.

They were of the moſt ſurprizing figures in the world, but ſtill they were all entire and healthy. By the external part one would ſcarce have ſuppoſed they had any coats at all, but, when broken, it appeared very plain. I thought they looked ſomewhat particular, being paler coloured than the reſt, but, when broken, they were all of the common lime-ſtone colour within, and the paleneſs was only in the coat they had obtained, which was different from the body of the ſtone.

In the ſame places with theſe I found ſome other ſtones, which were of the ſame odd ſhapes, but very different in their preſent condition. Theſe had no coat or covering like the others, nor had they any ſtrength or firmneſs; they were light and brittle, and ſome of them might be crumbled to duſt between the fingers.

It was very plain that theſe ſtones had been originally all of one nature and condition, but at preſent ſome were with coats and ſome without. Some alſo were ſound and healthy, and ſome decayed and rotten; and, without one exception, thoſe that had the coats were the ſound ones, and thoſe were rotten which had not.

The obſervation was very plain, and it ſtruck my imagination extremely, but for the preſent the conſideration went no farther.

It happened ſome time after that I had a ſecond opportunity of obſerving this matter; and that under the favour of more certain circumſtances. A pit was opened near the hot-well, that been dug in long before, and had lain, according to all accounts, covered up for about fifty years. On opening of this the ſecond time, there were found a great number of theſe odd ſhaped ſtones: they were in all reſpects like thoſe I had before ſeen near *Redland*; and, in the ſame manner, ſome of them were ſound and healthy, and others were decayed. In this place alſo, juſt as in the former, all thoſe that had coats upon them were ſound, and the few that had not coats were decaying.

I had now an opportunity of examining into this matter more perfectly. I had before obſerved, that there were no ſmall ſtones or pebbles in that part of the country; nothing of that ſize being found there but chips or fragments of rocks: and yet theſe ſound pieces had entirely the appearance of compleat ſtones, not having rough or naked ſurfaces, but coats or coverings.

When a quarry of ſtone is broke up, and they have taken out a quantity either for building, burning into lime, or whatſoever other purpoſe, there are always left ſome thouſands of chips and fragments of ſtone in the pit, and upon the ground about the place, now theſe muſt naturally be of all the irregular figures I have mentioned in the ſtones found about the quarries near *Redland*; if theſe are found afterwards covered with coats or cruſts, thoſe cruſts muſt have been acquired ſince the time of their being chip'd off from the rocks.

They are found covered in this manner, and it is plain that they are preſerved by this covering. They therefore obtain this coat, that is, a new matter ſurrounding and preſerving them; and they doubtleſs encreaſe in bulk. If therefore this is not vegetation, yet it is certainly a growth of ſtone.

In this quarry by the Hot-well we have an opportunity of knowing the time in which this could be done, as well as M. *Tournefort* had of determining the other by the dates. We find that fifty years ago this pit was dug. At that time a quantity of chips and fragments, of an irregular figure, were left in it. Theſe then had no coats, but were naked and raw pieces of ſtone. They have coats now, and appear entire ſtones; therefore this addition to the bulk and matter of ſtones may be made in fifty years, and I believe in much leſs time.

Notwithſtanding, I was now pretty well ſatisfied as to the growth of ſtone, yet I was determined to make all the enquiry poſſible into that matter, and accordingly I ſpent ſeveral hours in the pits near the lime-kilns upon *Durdham-down.* I found there alſo vaſt quantities of theſe chips or flakes that had obtained new coverings, and ſome quite rotten; thoſe that had acquired new coverings, were perfect healthy ſtones; and, when broke, appeared of the lime-ſtone colour; they had the ſame ring or ſound when ſtruck againſt; were full as hard, and had the ſame glittering particles with the ſoundeſt lime-ſtone from the rocks.

Theſe lay all expoſed to the weather; and though I was convinced they were all originally flakes or chips from the rocks, not only by their appearance when broke, but alſo by what I had ſeen at the opening of the pit a ſecond time by the ſide of the river near the Hot-well, to which place it could anſwer no manner of purpoſe, and muſt have been a very great expence for any one to have conveyed ſuch a prodigious quantity of uſeleſs ſtones of ſuch odd ſhapes and figures as were found there with new coats, had any ſuch naturally roſe out of the earth any where round that part of the country; but there is no ſuch thing.

I ſay, though I was convinced they came immediately from the rocks, yet I was willing to ſatisfy myſelf all I could in this ſingular and ſurprizing affair; and accordingly I applied to the oldeſt quarriers to know how ſuch quantities of odd appearances of fragments of ſtone came there, and they all aſſured me, they were originally flakes or chips from the rocks that had been left at the times of breaking up the different quarries.

If it be aſked, whether theſe chips or flakes obtain their coats or coverings in or out of the earth? My anſwer is, I verily believe they do in both. In the pits I am convinced they did when thoſe pits are filled up, as they were formerly, though of late years that is as much neglected as our gravel pits: and I think they muſt do ſo upon the earth, after they are once taken out of their natural beds and broke to pieces, for there are loads of them lying in and about the pits that have new coats, and are perfect healthy ſtones, which, I am perſuaded, were never under the earth ſince they were broke up.

There are alſo many larger pieces lie ſcattering up and down among the rocks which I had the curioſity to break. Theſe alſo had obtained new coverings. They were likewiſe found to be of the ſame nature with the rocks, and had all the ſame qualities; and theſe I am convinced were never under the earth ſince they were taken out of the pits. Theſe chips or fragments were all viſibly encreaſed in bulk, for when they are left, they are flat on the ſides, with ſharp edges; but theſe were all quite plump at their ſides, and their edges were become round and ſmooth.

No two of theſe chips or flakes ever adhere to each other, though they lie in great quantities together both under ground, and expoſed in the pits, but each gets a diſtinct covering, and becomes a perfect ſtone in the manner of a pebble, though of very odd ſhapes; and though the coats they acquire are but thin, I don't doubt but they are thick enough to preſerve them for many years.

And if it be aſked, how ſome of the ſtones come to have theſe coats and be found, and others to have none and periſh? I anſwer; that as the formation of theſe coats, like that of cryſtals and ſpars, depends upon the water draining down from the ſurface of the earth, and ſpreading itſelf over the ſurfaces of the ſtones as they lie covered up in the pit; if there be any part of ſuch pit where its paſſage is impeded, the ſtones lying under that part muſt want theſe advantages. This may eaſily happen by a large piece of ſtone lying flatwiſe, or by many other accidents, and then the ſtones lying under that part of the ſurface, would want this means of having a coat ſpread over them, and would decay; while thoſe that lay where the water had free paſſage, would get coats and be preſerved. And as to thoſe above ground, as their coats are alſo doubtleſs obtained by water's lodging upon them from time to time by the rains, and congealing itſelf, or depoſiting ſome concreting matter that covers the ſtone; ſo the different poſitions in which ſome may poſſibly lie, others being ſcreened by the ſides of the pits, or by the tops of the rocks that appear in great numbers above ground, or by large ſtones that lie about, may poſſibly prevent the rain's coming to them in a proper manner, by which they are prevented from acquiring a covering, and ſo go off and rot for want of it.

That theſe coats or coverings of the fragments of ſtone are added by degrees, and at ſeveral times, I can prove by the difference of the ſeveral pieces I have brought to *London*, the coats of ſome being rough, and thoſe of others ſmooth; and the rough ones being always thin, and the ſmooth ones thick in proportion.

Thus we ſee, that if the ſide of a joint of ſtone is left expoſed to the air, ſun, and rain, in its natural bed in the ſide of a pit, it ſplits and opens into vaſt numbers of thin pieces or diviſions, which all decay and go off in a very little time. But take ſuch joint of ſtone out of its bed, break it to pieces, and uſe it in building, and it will laſt for many years; or let it lie covered in, or even upon that very earth (for I could almoſt venture to ſay ſo much) and it will obtain a new covering that will preſerve it for ages. This is particular, but it is a fact; and the ſingularity of the ſubject, has made me dwell the longer upon it.

OBSERVATIONS

On the EARTHS, ROCKS, STONES, and MINERALS, about *Briſtol*, &c.

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BOOK the FOURTH.

Concerning the *Briſtol* WATER, or water of the HOT-WELL.

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CHAPTER the FIRST.

Of the riſe of the ſpring, and its general nature.

IF an apology were neceſſary for many things in the preceding parts of this treatiſe, much more is it ſo in this. As I pretend to be no naturaliſt, muſt leſs am I a phyſician. What I offer on this head, and on all the other occaſions, are the thoughts of a plain man, ariſing from the ſubjects as they offer themſelves to my conſideration. If they appear contrary to the doctrines of the phyſicians, they have my free leave to condemn them, and, if they pleaſe, to make themſelves merry with their author. But whatſoever they are, they ſhall be, to the beſt of my knowledge, true. The intent of my putting down theſe thoughts is not to ſhew talents, for I pretend to none, but to be uſeful; and I hope it will have that effect.

About two miles from the city of *Briſtol* are *St. Vincent*'s rocks. They are a vaſt and irregular heap of ſtones, with minerals and other ſuch matters amongſt them in various places; but the general ſubſtance of the rocks is lime-ſtone, and it is extremely hard.

The rock, out of which iſſues the famous water called the *Hot-well* water, and in other places the *Briſtol* water, ſtands on the north ſide of the river *Avon*, and affords a romantick and beautiful proſpect. The water is much admired in *London*, but its true excellency is very little known here, for, to taſte it in perfection, it muſt be drank warm from the ſpring. Thoſe who have not drank it there, cannot, from what they have drank of it elſewhere, form any real judgment as to its very flavour.

As this water paſſes through a vaſt bed of rocks, and among a variety of different ſubſtances, it doubtleſs borrows taſte and virtues from the moſt particular kinds; and, when drank at the ſpring head, it has a fine gentle warmth, nothing like the heat of the *Bath* pump: and a delicate ſoft milky taſte; and it is very grateful to the ſtomach, and very favourable in many complaints.

It is generally allowed to be cooling, cleanſing and balſamick; but one of its great qualities is its aſtringency: this renders it uſeful in that very terrible complaint the *diabetes*; and, in conſequence of its other qualities, it is drank with great ſucceſs in obſtructions of the urinary paſſages from gravel, as alſo in many of the chronic caſes which are leaſt to be relieved by the common courſe of medicine.

Its cooling quality makes it of ſervice in many of the internal inflammations; and, by its reſtringency, it ſtrengthens the ſtomach. Thoſe who uſe words I do not pretend to underſtand, ſay it conveys a fine balſamick ſulphur into the blood; but this they may explain alſo, if they think it convenient.

To ſpeak from what I know, it promotes an appetite, and aſſiſts digeſtion, and this without that effect upon the taſte of food which it muſt be allowed that many of the mineral waters have, and which is not at all agreeable.

When the lungs are too far gone, its uſe is to be avoided; but in the firſt ſtages of what would proceed to theſe dangerous inflammations; that is, in obſtructions, for I am apt to believe they are the origin of all inflammations, this water is admirable. There require ſome cautions in the uſe of it, as there do in that of all other medicines, becauſe whatever can do good, may do harm, but this requires fewer than any; and perhaps more good and leſs hurt have been done by it, than by any thing medicinal in the world.

When people firſt drink it upon the ſpot, and warm from the ſpring, it is often aſtringent in the bowels, and ſome few are perhaps deterred from continuing it, when there requires nothing but continuance to get the better of this little inconvenience which attends it only on the firſt uſe. People have alſo complained of unaccuſtomed uneaſineſſes in their head at the firſt drinking, and this has occaſioned perhaps more to leave it off than the other. They have got a phraſe of its flying up into their heads, and are alarmed at it; but there requires no more than the advice of any phyſician, or of that degree of knowledge in phyſick every man has who is not a fool at forty, to get the better of all theſe inconveniencies. The buſineſs is to proceed, but to do it prudently; the ill effects will go off, and all that could be reaſonably expected come in their place.

There are ſome others who leave off drinking with much more appearance of reaſon, but with no real reaſon at all. Theſe are ſuch as have continued it for ſome time without any ſenſible advantage. The effects of the water are ſlow, but in right caſes they are very ſure. Many who have left off as they ſuppoſed unrelieved, have found the advantage ſome time after, and then lamented they had not remained longer on the ſpot.

Some people, when they come in hot to drink the water, have thought it colder than it uſed to be; and others, when they come in cold, have thought it warmer; but, by the niceſt experiments made by Lord *Macclesfield*, it muſt be entirely owing to the temper of their bodies at that time, for the water ſcarcely ever varies at all with reſpect to heat or cold.

If thoſe who are under complaints, which it is reaſonable to ſuppoſe the *Briſtol* water can remove, and whom their phyſicians recommend to the uſe of it, will take the word of one who has no motive to ſpeak well of it, but from the benefit he has found, they will quickly take up the reſolution of going thither; for the water is equally good all the year.

Every thing conſpires to render the thing agreeable. The accommodations of all kinds are excellent, and there is good attendance. The people in general are obliging more than in almoſt any other place I know, and thoſe belonging to the Hot-well are particularly ſo. There is always good company; and the many innocent amuſements and diverſions during the ſeaſon, which is from *May* to *September*, contribute greatly to the pleaſure.

For thoſe who love riding, there is the fineſt country in the world; and, even for carriages, nothing can exceed it; the Downs are ſpacious and open, and we enjoy the healthful exerciſe in a pure air. Mean time there are the moſt agreeable proſpects of that vaſt ſheet of water *King-road*, often adorned with variety of large ſhips and veſſels, and the *Welch* mountains terminate the view on the other ſide of it; in ſhort, the whole country all round, is, during the ſeaſon, extremely beautiful and pleaſant.

Clifton, one of the moſt agreeable villages in the kingdom, preſents itſelf juſt upon the hill riſing from the Hot-well, for lodging. From the mount adjoining to it, there is another extenſive and glorious proſpect; and the air of this particular ſpot is ſo excellent, that it is called the *Engliſh Montpelier*.

The company frequenting the Hot-well are numerous, and to that is owing a part of the agreeableneſs of the place. But when I have riſen in a morning; when I have rode out at noon; and when for the reſt of the day I have felt the advantages of the water, I have wondered they are not greatly more.

Every fine *Sunday* indeed the place is all day long like a fair, vaſt numbers of people coming from *Briſtol*, and all round the country, to drink the water; but theſe go in a back way, and do not interrupt the better ſort of company. And there are conveniencies at all times for the poor to drink what water they pleaſe, which is a good charity, and doubtleſs does great ſervice.

The principal amuſements and diverſions of the Hot-well are theſe: the gentlemen frequently go in pleaſure-boats, attended with muſick, down the *Avon* to *King-Road*, and from thence to view the light-houſe upon the flat holms, but they always take care to return with the tide, the ſtream running ſo prodigiouſly ſtrong, that there is no ſuch thing as rowing againſt it. This is a moſt delightful pleaſant voyage, the windings of the river between the rocks and hills beautifully diverſifying the ſcene almoſt all the way.

The gentlemen alſo have many pleaſant rides over *Leigh-Down* on the *Somerſetſhire* ſide of the *Avon*, even as far as *Falen's-Inn*, and *Dundry-Tower*, from both which places ſcarcely any thing can exceed the proſpect, the latter being placed as a land-mark for ſhips in their paſſage up *Briſtol* channel.

The ladies ſeldom partake of thoſe pleaſures. Their amuſements and diverſions are pretty much confined to the Pump-room and the Long-room; not but that they have, beſides viſiting, aſſemblies, balls and plays alternately, to which they are carried in coaches or ſedan chairs, ſeveral of theſe always attending for that purpoſe.

Some ladies alſo take great delight in riding upon *Durdham-Down*, for which, if they have not carriages or horſes of their own, there are enough to be had: and the beſt lady attending the Hot-well, if ſhe does not chuſe to ride a ſingle horſe, will not refuſe riding behind a man, for ſuch is the cuſtom of the country, and numbers of what they call double horſes are conſtantly kept for that purpoſe.

In this manner they often go upon parties of pleaſure to *King's Weſton*, from whence they have a noble view of the country; ſome go to Eſquire *Southwell*'s, from whoſe ſummer-houſe there is certainly as extenſive and delightful a proſpect as can poſſibly be conceived; and many go even as far as *King-Road*, as has been obſerved already.

CHAPTER the SECOND.

Of the method of drinking the Briſtol *water on the ſpot, and elſewhere.*

I Shall be very plain in the directions and accounts I give on this occaſion, and perhaps ſhall ſay nothing but what a great many of my readers know as well before as I do; but they will pardon me for the ſake of thoſe who do not.

At the firſt coming down, the method is to go to the Pump-room in the morning, and drink a glaſs or two before breakfaſt; and about five in the afternoon to return and take another or two, moſt uſually two. This is the beginning if the water ſuits; that is, if the ſpring tides do not prevent it. The next day the perſon takes three glaſſes before breakfaſt, and three in the afternoon, and this he continues during the time he ſtays there.

Theſe glaſſes hold a third part of a pint apiece, and he is not expected to pour down three of them one upon another. Half an hour, by the Pump-room clock, is the time to be allowed between glaſs and glaſs; and in this time he either ſits on a bench in the Pump-room, the muſick playing every morning during the ſeaſon, to whom, if he chuſes it, he ſubſcribes five ſhillings; or elſe he goes out into the walk by the ſide of the river *Avon*; on which river great trade is continually carrying on, numbers of ſhips and veſſels going to and from *Briſtol* with every tide, which runs at a prodigious rate, the large ones generally ſaluting the company at the Hot-well with two or three guns as they paſs by on their arrival from foreign parts. The taſte of the water is ſo agreeable, juſt drawn, that the drinking this quantity is far from a taſk; 'tis univerſally done with pleaſure; and many are as fond of it as of wine.

Beſides the ſix glaſſes a day which I have mentioned as the common quantity drank, ſeveral perſons take one glaſs an hour before dinner; which has been found, with many people, a very good cuſtom, but not univerſally. With ſome it encreaſes the appetite to dinner, with others it takes it away. The laſt ſhould not uſe it.

Beſides this addition to the quantity drank, many people ſend for it to their lodgings, and drink it as common water, alone, with their wine, or in punch; and make their tea with it. All this is right; its taſte is not different from common water, any otherwiſe than as it is more agreeable. And this is a very proper way of adding to the advantage they receive from it.

When a man has drank his three glaſſes in the morning, he ſuppoſes he has taken his breakfaſt, but his opinion laſts but a little time: in an hour after he finds, by very plain tokens, that he muſt have another; which he is ſure to eat with more appetite, and more ſatisfaction, than if he had not taſted the water.

People who are ſo ill as to have no natural appetite to this meal, get one by the water. They ſeem full with it when they have firſt drank; but in the ſame manner, after an hour, they find they have, if not ſuch an appetite as thoſe who are in better health, yet much better than they had before.

Although the advantages that may be had from drinking the *Briſtol* water are much better obtained upon the ſpot than any where elſe, yet there are ſufficient teſtimonies that it poſſeſſes its virtues at a diſtance, on which account great quantities of it are continually ſending abroad.

Thoſe whoſe affairs will not permit them to leave *London*, and whoſe conſtitutions require its aſſiſtance, have it here at fivepence the bottle, if they write to Mr. *Barratt*, the maſter of the Hot-well, for a hamper of it to come by ſea, a price ſufficiently moderate; but I ſhall recommend to them one circumſtance, by which they will greatly add to its efficacy.

I am convinced, that beſide the virtues this water has from the ſeveral ſubſtances among which it paſſes in the earth, it has ſome advantage from its warmth, which, though not ſo hot as that of the bath, is mild and gentle, and excellently ſuited to the temper of the human frame. This may be communicated to it in *London*, and the benefit of drinking it will be the greater.

In general it is never to be ſet in cellars: all cold and damp hurt its virtues; and the warmer and drier it is kept the better. At the time of drinking it I ſhall alſo adviſe ſuch perſons to have a tea-kettle of water boiled, and ſetting the bottle of *Briſtol* water in a pan, with the cork taken out, to pour the boiling water in up to the neck. Let the bottle ſtand in this hot water a few minutes, and I have found that it communicates to it, very nearly, that degree of heat which it has when juſt taken from the ſpring; and this not only renders it more agreeable to the taſte, but makes it exert all its virtues in the greater perfection.

There is yet one advantage I muſt needs give to the *Briſtol* water upon the ſpot, over moſt other medicines, which is, that it coſts nothing, or what is ſo near to nothing, that thoſe who are uſed to the daily viſits of the doctor, and the ten ſide bills of the apothecary, if it were twenty times as much, would call nothing.

No price is paid for the water: all the expence that attends the drinking of it, is, that every one, when he goes away, makes a preſent to the maſter, and a trifle to be divided amongſt the ſervants. This is at his own pleaſure, but is generally proportioned to the number of the family, and time of the ſtay. It is however a very inconſiderable thing when done ever ſo genteely.

One thing more I muſt alſo name in favour of *Briſtol* (phyſicians by your leave) which is, that a doctor is ſeldom neceſſary. Every ones own diſcretion, with the advice of the people who are about him, and have drank it already, being very ſufficient. At *Bath* the doctor's fee is almoſt a certain tax upon thoſe who drink the water. When a perſon arrives, who is a ſtranger to the place, he hears on every hand the virtues of the water celebrated to the ſkies, but then he hears at the ſame time they are not to be trifled with. The *Engliſh* of this is, you muſt not preſume to drink them without giving the doctor his guinea; for which he adviſes you to begin with a ſingle glaſs, and encreaſe as it agrees with you; and, to ſave appearances, ſome trifling preſcription is given you, directed to his favourite apothecary. This one would ſuppoſe needed no ſon of *Æſculapius* to tell people. Perhaps there does not, but the ſon of *Æſculapius* wants his fee, and it would be too bold a cuſtom to demand it of you for coming into the town where he lives.

The taſte of the *Bath* water, when between hot and cold, which is manifeſtly ſteely and ſulphurous, convinces people of the ſtrong medicinal qualities of it, and gives ſtrength to the inſinuation of the poſſible danger. This gives the doctor an opportunity of repeated fees with many; whereas at *Briſtol*, the taſte of the water is at all times ſo mild and gentle, that people ſee there is no neceſſity for the advice of a phyſician to prevent its ill conſequences: and it were well if thoſe gentlemens fees were all the ill that ſometimes attends their officious ſervice.

At *Briſtol* people may be ſick as well as elſewhere; and the greater part come in ſome degree ſo: but as they expect their relief from the water, they ſeek no farther; and excepting for now and then a preſcription for a bottle of drops to an old lady, or ſome ſalts to a fine gentleman who wants to ſoften his complection, the doctor ſeldom picks up many guineas.

There is one cuſtom of the phyſicians at *London*, which indeed reſpects *Briſtol*, and it were to be wiſhed, integrity would for the future ſo far prevail over intereſt, as to prevent it. I have mentioned the uſe of this water in obſtructions of the lungs: and a great part of thoſe, whom conſumptions carry off, I do believe might be ſaved by it alone, if they applied in time. The phyſician is the guide in this caſe, and he keeps them in town till recovery is impoſſible: till their lungs are in ſuch a condition, that nothing could reſtore them but creating new ones, and then ſends them to

Briſtol to die, but ſtill recommended to the care of his favourite phyſician. And thus I am afraid, by a thirſt after gold, the unhappy patient is too often play'd out of one hand into the other, from the doctor in *London*, to the doctor at *Briſtol*, and from the doctor at *Briſtol*, to his favourite apothecary, till at laſt he is play'd out of his life. This was the caſe with three perſons whom I ſaw there, and whom I knew, and often converſed with the laſt ſummer; and I am firmly of opinion, by the benefit I ſaw others receive who were afflicted with the ſame diſorder, but in a leſs degree, that every one of them might have been ſaved, by applying to the ſame remedy in better time.

CHAPTER the THIRD.

Concerning the origin of the Briſtol *ſpring, and of the virtues of its water.*

IT may be expected, that having written ſo much with an intent to uſe, I ſhould devote one chapter to curioſity, and examine what and whence this water is: how the ſpring is ſupplied, and whence it obtains its virtues. I am not enough in the depths of nature to know this, nor in the depths of philoſophy to gueſs at it; but however, being altogether diſſatisfied with what I have lately read upon that ſubject, I ſhall offer my opinion, ſuch as it is, in few words.

As to the virtues of the water, whatſoever they are, they muſt be very cloſely united with its ſubſtance, for they are not owing to the common accident of other ſubſtances being diſſolved in it. When we examine many other waters by evaporation, or boiling away, there remains a ſalt which poſſeſſes the ſame virtues; or elſe an earthy matter to which they have in ſome degree owed their origin; but nothing like this is the caſe, when we make the Hot-well water the ſubject of the like experiments.

When a gallon of the *Briſtol* water has been evaporated, there ſcarce remains any thing perceptible in the veſſel. This is a proof that its virtues are inherent in itſelf, not owing to any accidental mixture with it; and for this reaſon it keeps better than any other medicinal water whatſoever. The people upon the ſpot are extremely careful and expeditious in the putting it up in bottles, taking it up at the beſt time, and corking it inſtantly to preſerve its ſpirit, that ſcarce any thing is loſt; and we find it, whether on the ſpot, or at a diſtance, one of the pureſt waters in the kingdom. Vaſt quantities of air bubbles riſe in a glaſs of it freſh filled and expoſed to the ſun; and with all the ſoftneſs of its taſte, it will not lather with ſoap unleſs firſt boiled.

Such is the character, and ſuch are the qualities of this water; it remains to conjecture whence the ſpring is ſupplied, and how it is impregnated. I am ſenſible that very pompous accounts have been given of its being impregnated by air, and ſent up from a great abyſs; but theſe are things too myſterious for my common capacity: I ſhall therefore endeavour, as well as I can, to make my own conjectures, and offer them to ſuch as myſelf for conſideration.

It is a moſt plentiful ſpring, and conſequently it muſt be ſupplied from ſome vaſt reſource. Like moſt other ſprings it riſes in wet weather, and falls in dry, ſo that it has much in common with waters of leſs virtue. But this is alſo to be obſerved, that they are obliged to leave off pumping a few hours in the day, always for a day or two before, and two or three days after every new and full moon.

This is owing only to the accidental ſituation of the ſpring near the bed of the *Avon*, for, at the times of all ſpring tides, the ſalt water of the river *Avon* riſes very high, and uſually ſo high as to break in upon the Hot-well ſpring.

When there has been much rain however, and the ſpring is full, it in a great meaſure reſiſts the ſpring tides, which then affect it but little; and, in the ſame manner, when the ſeaſon is very dry, and the ſpring low, the ſpring tides affect it the more.

This might apppear a very formidable diſadvantage, but it is in effect very trifling: the ſpring is ſo conſiderable, that it will bear continual pumping; and a few hours of this, in the very worſt times, render the water bright and pure again as at firſt.

There is ſomething very ſingular in the nature of this ſpring, and very ſtriking to common obſervation. The face of the country is the very ſame for a great extent; and, as has been obſerved already, the rocks run all over it in the ſame manner, the bed of the *Avon* being only a kind of cut made by the water through them, and not any real ſeparation of one kind of ſoil or country from another; yet although we ſee, on the other ſide of the *Avon*, the ſame kind of rocks of the ſame lime-ſtone, and every way alike with thoſe on this ſide out of which the Hot-well iſſues, and ſee ſprings in the very ſame form and manner iſſuing from them; yet the water of the one and the other of theſe ſprings, has not the leaſt affinity. That of the Hot-well being warm and ſoft and medicinal, as obſerved already; and that facing it on the oppoſite ſhore, being as hard, as cold, and as ſimple rock water as any in the world.

It is not my intent to cavil at thoſe who have profeſſedly written upon the virtues of theſe waters, and who have I hope ſtudied them to more advantage than my education and opportunities would permit me: but I ſhall frankly deliver my opinion; and, ſo far as it is contradicted by theirs, I ſhall think it a duty to name them, that I may not ſeem to have ſtarted my own gueſſes for want of knowing what had been determined by others.

Whatſoever may be ſaid by Mr. *Boyle*, and thoſe who are proud to quote him, concerning the difficulty of aſcertaining the virtues of medicinal waters *a priori*, as they call it, it is my opinion, that the true ſource of the virtues of *Briſtol* water, is that great rock of lime-ſtone through which it runs before it reaches the place where it is pumped up for uſe. I am ſenſible that all the good effects it produces, and they are very numerous, may be derived from the qualities it may obtain from that rock alone, and therefore why ſhould we ſeek any farther.

How rocks and minerals become able to communicate virtues to water for ages together, or how indeed they do it but for a little time, I ſhalt not take it upon me to explain; but this I ſhall obſerve, in favour of the lime-ſtone rocks retaining their ſtrength and vigour, though ſprings paſs through them, that obſervations, in many other inſtances, confirm me, that, far from injuring or impairing the rocks, this paſſage of water under them and through them, is the very thing to which they owe their principal ſtrength, and that, without this, they never will continue in that ſound condition which I call their ſtate of health.

It appears to me, from repeated obſervation, that ſprings are, as I may ſay, the life and ſupport of rocks; and that while the waters flow under them, they will be ſtrong and healthy, and never loſe their virtues or their qualities; and, on the contrary, that rocks do loſe their weight and ſoundneſs, and every quality which before diſtinguiſhed them, when by any accident the ſprings forſake them. Nay, I have ſeen ſo much of this, that I verily think the decayed rocks, which are found at depths under the earth, owe their decay as much to the water's having changed their courſe and forſaken them, as to extreme old age itſelf. In all places where ſtone has ſomething of a moiſture in it, that ſtone is firm, and where it is quite dry, it will break to pieces, and is light and rotten.

It has been ſhewn, that the water which, ſinking down from the ſurface, ſurrounds theſe rocks, is full of matter that can concrete into ſtone, perhaps this continually, though ſlowly, pervades the very ſubſtance of all rocks, and while it works out ſome part of their matter, leaves other in the place: if this be the caſe, and the impregnation of this water be from ſome of theſe particles thus at times introduced and carried off again, and that in a continual ſucceſſion, there is no wonder that the ſame rock can ſupply the water which waſhes it with virtues for ever.

We know the qualities of lime-ſtone ſufficiently well, and we know they are ſuch as would give the very virtues to water which this *Briſtol* water poſſeſſes. We ſee that there are vaſt quantities of theſe lime-ſtone rocks lying a mile or two in the earth from the Hot-well; the qualities of theſe we alſo know. And as the waters iſſuing from them are ſtrongly impregnated with thoſe qualities, what can be more natural or more juſt than to conclude, that they receive their virtues from them.

Whatſoever it be that gives theſe virtues, there is this very ſingular; that the waters iſſuing from the rocks of the ſame ſtone on the other ſide of the *Avon*, as has been already obſerved, do not afford the leaſt inſtance of it, or any mark of poſſeſſing any quality at all more than common water. This is very ſingular, and would lead one to think that nature had ſo contrived it, that this water ſhould not waſh the very rocks among which it paſſes.

That this is the caſe with reſpect to the impregnation of the *Briſtol* water I make no doubt: it remains to conſider in what manner the ſpring is ſupplied; and in this I am afraid I ſhall differ conſiderably from an author who has lately written on the ſubject, as well as in my opinion of their impregnation. He ſays, that it is furniſhed from a great abyſs. For my own part, I am of opinion, that it is ſupplied like all other ſprings, and that from no abyſs. Let us ſee his reaſons together.

It is not this ſpring in particular which he ſuppoſes to ariſe, from an abyſs; he imagines all the great rivers in the world to be ſupplied in the ſame manner, and gives for his reaſon, that moſt of the water which falls in rain, muſt be required for the ſupport of the vegetable creation.

But thoſe who were beſt able to judge, have already determined, that the common exhalation, and conſequently the deſcent of the waters, are fully ſufficient to ſupply all the rivers and ſprings in the world; and therefore we need not have recourſe to that ſtrange and unintelligible doctrine of an abyſs, for the feeding them. I know ſome term importing the ſame thing is uſed in ſcripture, but the deſignation of it is not ſo punctual, but that we may argue about the meaning; and before I allowed ſuch a term to out-weigh reaſon and obſervation, I ſhould be apt to get it very exactly tranſlated from the *Hebrew*.

If we aſk what power or agent it is that raiſes up this vaſt abundance of water from the abyſs he ſpeaks of, and ſends it to run over the earth, he ſays there is a circulation of it from the centre to the ſurface: he, with all the *Burnett*'s and the *Woodward*'s in the world, for I am told thoſe writers maintain ſome ſuch doctrine, would, I am very ſure, be puzzled to get over the natural obſtacles to ſuch a circulation; but 'tis not my buſineſs here to propoſe them.

It may be allowable to anſwer ſuch a reaſoner upon his own principles. If he aſks, as that is one great article of his work, how it comes that theſe lime-ſtone rocks, by which we ſuppoſe the waters of the Hot-well to be impregnated, do not loſe their virtue? To what has been ſaid already, I ſhall add, why do not the fires of *Ætna* and *Veſuvius*, which he quotes as inſtances in his favour, fail? Or where is the wonder that one of theſe things ſhould retain its nature as well as another?

If we are to allow the water of the Hot-well to come from a great abyſs, we muſt allow all other ſprings to have their waters from the ſame ſource, for there is no difference in the circumſtance; and if any ſhould aſſert this, let us aſk him, how it comes about, that ſome ſprings, very hot, and others perfectly cold, riſe almoſt in the ſame ſpot of ground; and in the ſame manner how it is, that ſprings of medicinal quality,

lity, and thoſe which run with only common water, do, in the ſame manner, riſe juſt by one another? This is the caſe in many parts of the world; and the queſtion is unanſwerable. The thing is fact, and therefore that account which it contradicts, is falſe.

Upon the very principles of this doctrine of the ſprings being all ſupplied from an abyſs, as delivered by this gentleman, and by thoſe who had ſpoke upon the ſame ſubject before him, it ſhould happen, that theſe ſprings ſhould be low when there was much rain; and, on the contrary, that they ſhould be high when there had been very little rain. But let us examine the matter, and we find it exactly otherwiſe. The *Briſtol* ſpring, and all the other ſprings in the world, are high when there have been rains, and low in continued dry weather. This alone convinces me, that they owe their riſe to rains only; on the quantities of which they ſo abſolutely depend for their fulneſs.

Having, in the courſe of this natural enquiry into the cauſe of the virtue of theſe waters, of neceſſity mentioned the account given of them by another perſon, whoſe ingenuity I eſteem, although I do not in all things ſubſcribe to his opinions, I ſhall think it incumbent upon me to enquire into his ſyſtem a little farther, leſt I ſhould be accuſed of dealing partially with him, or of anſwering what I thought proper, and leaving the reſt alone.

Now I muſt confeſs that the firſt thing which gave me an objection to his ſyſtem, was the unnaturalneſs of it. Perhaps I may err in this, but howſoever I ſpeak my opinion: it appears to me unnatural. I have heard great men ſay, nature always takes the ſhorteſt courſe, and does things in the moſt eaſy manner. Now I muſt need ſay my way of the water getting its virtue ſeems very natural, and his is neither the ſhorteſt courſe, nor the moſt eaſy, for which reaſon I never could bring myſelf to like it.

Theſe high learned and ſpeculative gentlemen, when they puzzle a cauſe that was plain before they meddled with it, put me in mind of what I have been told of a certain king, who having a very clear head, and being deſirous of knowledge, ſent to a famous aſtronomer to inform him of the ſtructure of the heavens, the revolutions of the planets, and the like. When he had heard all this ingenious gentleman had to ſay, and perceived him having recourſe to circles upon circles, and many other ſuch things, "I am ſorry, ſays he, I was not "called to the council upon theſe matters, "I could have ſhewn a way to do this with "half the trouble." The ſaying was odd, but there was no body to blame for it but the aſtronomer. He lived before the true ſyſtem of the univerſe was known, ſo he gave a falſe and perplexed account of it: by and by came *Newton*, and made all eaſy. If the king had heard his ſyſtem of things, he would never have ſuppoſed he could make them better.

Juſt ſo it is in every thing that belongs to nature. They that explain things in the ſimpleſt manner, generally explain them trueſt; and when people, to ſhew their learning, go farther about, they only miſrepreſent what they talk of, and ſerve themſelves the trick of the climbing monkey. I ſhall not repeat the proverb.

In the firſt place I believe thoſe who underſtand chemiſtry will ſay it is a very odd principle he ſets out upon, that reaſon teaches us a chemical examination (I ſuppoſe *analyſis* means that) is not the way to know what gives the water its virtues. For my own part, though no chymiſt, I cannot help thinking there is no way to know what a thing is good for ſo well as to ſee what it is made of; and in the ſame manner, I think if I knew what it was made of, I could gueſs how it came to be good for ſuch purpoſes.

For inſtance, if a man aſked me what made *hiera picra* purge, and another was to find, upon *analyſis*, that there was aloes in the *hiera picra*, I ſhould naturally think that a very good account of the reaſon why it purged me. And I ſhould think the *analyſis*, which ſhewed me that there was aloes in *hiera*

hiera picra, was a very proper method of finding out what gave the medicine its virtues. I am a plain man, and can only make alluſion to common things, but I am of opinion they will ſerve the purpoſe as well any other.

As to what this author ſays of the diſagreement of writers on this matter, I place little weight upon it: he may ſee I think not half ſo much of all the authors in the world, as of plain reaſon and experience.

For my own part, I cannot help thinking that this gentleman's own experiments, which he mentions, tend to prove what I ſay, inſtead of doing any thing for his account. It is my opinion, as already obſerved, that the water owes its virtues to the limeſtone rocks. They are at hand to give it, and doubtleſs it runs through them: and this gentleman himſelf ſays, that both lime water and *Briſtol* water turn green with the ſyrup of violets; and both lime water and *Briſtol* water ferment with the ſtrongeſt acids. Does it not appear from this, ſo far as the experiment ſhews any thing, that lime water and *Briſtol* water are of the ſame nature.

But I cannot forbear obſerving upon what follows, that he alſo thought they were alike, becauſe, upon mixing oil of vitriol with them, there was a heat in the mixture; but he afterwards found this ſignified nothing, becauſe there was the ſame heat when oil of vitriol was mixed with common water. This gentleman it ſeems did not know before, that oil of vitriol and water grew hot together, no matter what water it may be. Doctor *Shebeare*, whom he names, would have ſaid to him, fie fie, learn the common properties of things, before you ſet up for an experimenter.

But is this to ſhew that *Briſtol* water and lime water are not of kin? What becauſe they both are originally common water, and therefore are like common water, is their likeneſs to one another no proof they are of the ſame nature. He might as well ſay, becauſe both of them will wet things, and common water will wet things, that although *be really thought once there was ſome* *very great reſemblance between them*, he finds it no more than between each of them and common water.

Both of them turn hot with oil of vitriol, and ſo does common water, and therefore this is no proof they are alike : very true, but both of them turn green with ſyrup of violets, and both ferment with acids ; now common water does not turn green with one of theſe things, nor ferment with the other, therefore I ſuppoſe they really have a very great reſemblance, and that it would be more to this gentleman's credit to think ſo ſtill, than to ſay that he once thought ſo.

As to thoſe experiments which anſwer differently with lime water and *Briſtol* water, they make nothing againſt what I ſay. For I do not pretend to ſay lime water and *Briſtol* water are the ſame : common ſenſe denies that : wherefore then ſhould they anſwer alike upon all tryals ? I only ſay that the *Briſtol* water has its virtue from the lime ſtone rocks, and to ſupport this, it is ſufficient that they have a real reſemblance one to the other ; and this is ſufficiently proved by their anſwering in the ſame manner upon ſome particular and ſtrong experiments.

Thus far therefore, in arguing againſt my opinion, he helps to prove it. And as to his grand objection, that if waters were impregnated from what they took up from the rocks in their paſſage, they would exhauſt the rocks, although many people before him have ſet it up, I have anſwered it very fairly; and, by what I hear, I do not find it was ever anſwered before: I ſhew that the rocks receive a continual ſupply of this very matter of which lime is made: therefore they can never be exhauſted. And this is not ſtarted on purpoſe to get over that difficulty, but will be found to be of a piece with the reſt of the book, and to agree with every thing elſe ſet down in it.

As to the other ſprings, I ſay nothing to them, for they are nothing to the preſent purpoſe. If my account of the *Briſtol* water can be ſerviceable in accounting for them, I ſhall be glad; but others may ſee to that.

Thus is my plain ſyſtem of the origin of the virtues of the *Briſtol* water to be made out and ſupported: but I think nothing can be more ſtrange and fanciful than his account of the matter. In the firſt place the water is not to come to this or any other ſpring from rains, but it is to be raiſed from an abyſs. And then how is it to get its virtues? Why, it is to paſs quietly over rocks of lime-ſtone, and though its qualities and virtues are exactly thoſe of water impregnated with lime-ſtone, they are not to be obtain'd from thence, but it is to be owing to impregnated air.

To be ſure he takes care that what he ſays ſhall not want the authority of antient and modern people to ſupport it. *Homer* and *Plato* are called upon to ſhew that there was a circulation of waters from the centre of the earth to the circumference; or elſe to ſhew that he had read them: and Dr. *Woodward* is brought in as an evidence, that air pervades all parts of the earth and water. As to Dr. *Woodward*, I am afraid I have found experience and him at variance before now in this work, though I am very careful to name it. And as to *Homer* and *Plato*, all I ſhall ſay about them is, that I am afraid their teſtimony would not be taken in a modern court. Beſide, I am fully perſuaded neither of them knew any thing of *Briſtol* water; for which reaſon I ſhould pay no great regard to them in that queſtion.

As to the burning mountains of *Ætna* and *Veſuvius*, which I have already obſerved that he quotes, I am really afraid they make againſt him rather than for him in this matter; for though it is true they have continual fire, as well as the water continual heat and continual virtue, yet if the cauſe were the ſame, or but of the ſame nature, they ought to be equal in heat like the water of this ſpring, or elſe this ſpring to be unequal as they are.

And laſtly, to name thoſe cavernous hollows in which he ſuppoſes the water to obtain its virtue from this impregnated air, I ſhall only obſerve, that as he mentions them only as matter of conjecture, I ſhall take the liberty to paſs them over as *chimeras*, till he has ſhewn that they are realities.

I ſhall not enter into more particulars, for my intent in all this is not to decry his book, but only to defend my own plain ſyſtem from the objections which might be raiſed by ignorant perſons from his high-flown ſuppoſitions. Nature and reaſon ſpeak for my ſyſtem; and it is ſupported by experiments; even by the very experiments which he has brought in to help his airy ſcheme.

Before I finiſh my account of the *Briſtol* water I would juſt obſerve, that many perſons who have weak and enflamed eyes often receive great benefit from it. They take it warm from the pump in ſome little cup, and with a bit of ſoft rag waſh their eyes pretty often with it, this in time cools the part, takes off the inflammation, and greatly ſtrengthens the eyes.

There is another advantage attending the Hot-well, from which many people have alſo received benefit, and therefore it ſhould not be forgot. And that is, the ſeveral little private baths for one perſon only at a time. Theſe are chiefly frequented by thoſe afflicted with different kinds of weakneſſes. When ſuch perſons firſt go in, they generally imagine it rather weakens than ſtrengthens them, and often complain of weakneſſes in their backs and joints for the firſt week or ſo, but afterwards they find they gather ſtrength.

Many perſons alſo in health often make uſe of theſe baths, in order to cleanſe and refreſh themſelves, which they do to admiration. When a perſon goes into the little room where the bath is, he takes the key of the door in with him and undreſſes himſelf. He then takes hold of the iron rings which are faſtened in the walls, and ſtepping backwards down two or three ſteps, dips his head under water two or three times as ſoon as poſſible, and afterwards ſtays in perhaps five or ten minutes.

The water which fills theſe little baths, is the ſame with that which is drank, but by the time it is pumped up through the cold leaden pipes into theſe ſtone baths, you can ſcarcely feel any warmth in it. Theſe baths are uſually beſpoke on the over night by thoſe who chuſe to bathe early, and they have them ready to their hour in the morning, for which they pay one ſhilling each time, the bath being freſh filled for every perſon.

There is one thing more I muſt take notice of, which is this, I would by all means adviſe thoſe gentlemen who ride on horſeback to the Hot-well, as many do, to put up their horſes in the ſtable over-againſt the beginning of the walk, for which they pay only one penny a time for each horſe, and not to tie them up to the rails while they drink the waters.

This laſt is a very common practice; you ſee a whole range of them together; and the conſequence is, that almoſt every morning one or other of them is obliged, by the backing of coaches or chariots againſt them, either to break his bridle, or to pull down part of the rails.

By this penny-ſaving ſcheme of the owner, the horſe is greatly frightned, and often receives an injury, while his maſter is ſitting in the Pump-room, or is got to the coffee-houſe adjoining to it to read the news papers, and knows nothing of the matter. Many a good horſe has been hurt by this bad practice, and the company, who are in the walk, are frequently alarmed by it.

Pla. I.

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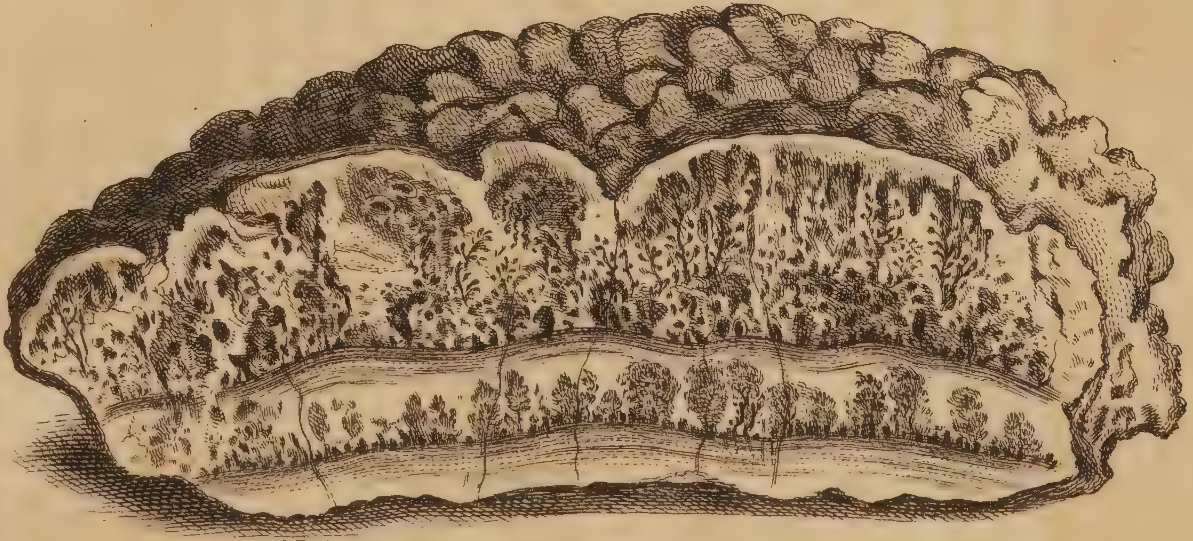

The Cotham Stone.

J. Mynde ſc.

OBSERVATIONS
On the EARTHS, ROCKS, STONES, and MINERALS, about *Briſtol, &c.*

BOOK the FIFTH.
Containing an account of certain STONES of a very particular kind.

CHAPTER the FIRST.
On the Cotham *Stone.*

I HAVE taken the liberty of making uſe of a new name in the title of this chapter, but it is upon a very fair occaſion. It has always been allowed people who were to ſpeak of things which, not being known before, had no names at all, to give them ſuch as they thought moſt proper. That this is the caſe with reſpect to what I have called the *Cotham* ſtone, I am aſſured by thoſe who have ſeen it, and who would have known if it had any other name already. As it has not, I ſhall call it by one which I think the moſt familiar I could have found, and by which it is already known in that part of the country. It is called after the name of the place where it is found, and where it will always be to be met with, for there is ſufficient plenty of it.

I ſuppoſe thoſe who are in the ſecret of writing books will tell me I ſhould have called it by a name expreſſing its colour or its qualities: perhaps they may be in the right, and they may, if they pleaſe, do this for me, in the mean time they may call it by this, till their own wiſdom has furniſhed them with a better.

In ſome places about *Briſtol* I met with a very beautiful ſort of ruſtick work in the ſtone facings of the gateways leading to the better houſes, and in other the like pieces of building. I often admired it very much; and thought but meanly of the *London* workmen, who ſuffered themſelves to be ſo vaſtly excelled in a conſiderable part of their profeſſion by people in the country.

The beauty of the ruſtick work we ſee about gateways and elſewhere in *London*, is owing to the great variety and ſtudied irregularity of the appearance, but this, in the very beſt pieces I have met with in *London*, was nothing to be compared with that which I now ſaw in the country.

There is alſo another advantage the *Briſtol* ruſtick has over all that is to be met with about *London*, which is in the nature of its ſurface. I would not be underſtood to accuſe the common ruſtick for being rough on the raiſed parts, for I know that is intended; but there is a degree and manner in which this is proper; and in *London* it is all carried to exceſs.

The *Briſtol* ruſtick not only has the raiſed parts thrown into a variety of forms and combinations not to be ſeen in any other; but the ſurface of theſe raiſed parts is itſelf the moſt elegantly done in the world. All the raiſed parts are of a rounded form, and their ſurfaces, though not even or ſmooth, yet have a general aſpect of equality; they are curdled or waved as it were in a variety of directions equal to that of the diſpoſition of the parts themſelves; and they fill the eye, without offending it, in a manner that I never ſaw in any thing of the kind elſewhere.

When I have been called by the beauty of theſe pieces in the work to a nearer view, I have admired them more and more. When I have viewed the whole thus nearly, it appeared not a piece of common ruſtick, but an imitation of ſomething much more elegant. The depths of the hollows between the riſing parts is varied, and their form different, in ſo ſtrange a manner, that no two are at all alike: and the waving and curdlings of the ſurface in the raiſed parts is ſuch, that every one of them ſeems a piece of ruſtick in miniature, the whole ſurface being formed, like that of the maſs, into riſings of the moſt elegant kind, and irregular hollows between them.

This is the general aſpect of theſe parts of the work when viewed near and at a diſtance. But there are accidental variations that ſtill give them a new aſpect and new beauty. Sometimes the higheſt part of one of the riſings of the ruſtick, and ſometimes not only one but two or three of them are ſtripp'd as it were of their outer coat; in theſe places there appears a ſmooth poliſhed and deep brown ſurface. This is the moſt prominent part, and, by degrees, there riſe round this, ſhells of coverings very thin, and extended one behind another, till the outermoſt becomes curdled and waved; and then begins the general ruſtick work as on the reſt.

I was ſurprized to ſee ſo much work thrown away in places where it could not be expected to be ſeen, for I naturally thought few, except myſelf, who admire this ſort of curioſity, would have examined them ſo nearly.

CHAPTER the SECOND.

Of the outer ſurface and appearance of the Cotham *Stone viewed ſingly.*

MY wonder upon this ſubject was, after ſome time, turned another way. I found it was not art and labour, but nature that I was to admire in theſe wonderful pieces of ruſtick; that no tool had ever been near them, but they were as they had been found in the earth, and the maſon had put them into theſe places, and claimed no other merit in them.

Theſe were the *Cotham* ſtones of which I am treating in this chapter. The place from which they are named, *Cotham-Houſe*, is but a little way from *Briſtol*, and near this houſe there is a great bed of theſe ſtones: all that I ſaw of them, which were a vaſt number, had the ſame curdled and waved ſurface. I ſtood aſtoniſhed at the ſight. They had the appearance of the implicated roots of trees, or ſtems of old ivy growing over one another about ſome old wall. They reſembled the thick and tuberoſe roots of the *Flower-de-Luce* in our gardens, which creep upon the ſurface of the ground, and entangle with one another. They were alſo of the ſame colour nearly with theſe, for the ſtone is of a pale brown, and the ſeveral riſings were like the parts of that root, their thickneſs being from three quarters of an inch to two inches.

Examining theſe, I was ſoon led to underſtand the variety of thoſe I had ſeen employed in the buildings, for art had no ſhare in their beauty. I have named that ſome of the riſing parts were ſmooth at the top. I ſaw many inſtances of that here; the rough ſurface of theſe prominent parts I now diſcovered was no more than a coat or covering of a paler coloured matter than the reſt of the ſtone, as is the uſual caſe, and this ſmoothneſs of certain parts was owing to their having been rubbed ſo that the coat was off.

The ſeveral circles or thicknings about this part, before the coat was compleated, were alſo ſeen to be only parts of that coat, and I diſcovered by this, that the rough coat itſelf was compoſed of a great many thin coats laid over one another; in ſome of theſe places I could diſcover eight or ten of them.

This ſtone does not lie in a continued maſs, but is in ſeparate lumps. Many are about two feet, or two feet and an half in length, and of irregular figure. I was determined to examine a ſtone ſo beautiful as this thoroughly; and I would recommend it to all thoſe, who admire any work of nature, to do ſo; for the deeper they go, the more cauſe they will always find for wonder and admiration.

When I had examined this upper ſurface in a great many of the ſtones, and found it alike in all, I determined to examine every other part. I turned up ſeveral of them, and as the upper, ſo the under ſurface was alike in all. As the upper ſurface was raiſed into irregular protuberances, this was ſunk into as irregular hollows; and it was eaſy to ſee, from the general ſtructure of the ſtone, that theſe were owing to the ſame cauſe, and to one another.

The under ſurface has the appearance of clay rather than of ſtone, but, when examined, it is hard as the reſt: the hollows in it are uncertain in number, but the riſings on the upper ſurface, though they are much more numerous, always anſwer in a general manner to them. They are an inch in depth or leſs, and two or three in length or breadth, and both theſe, and the ſpaces between them, are of a very irregular ſurface, and ſerve very happily to explain the origin of the ſtone.

I have mentioned that the rough cruſt, which gives the appearance of ruſtick to the upper ſurface of this ſtone, is formed of ſeveral thin coats lying over one another. The whole ſtone appears to be ſo, and here they terminate irregularly, and ſhew themſelves by their edges. The parts of multitudes of cruſts, of the thickneſs of paper, are diſtinguiſhed on the under ſurface in and among the hollows.

I have obſerved that the figure of the ſtone is irregular, but it often approaches either to round or oval; and its thickneſs, in a ſtone of two feet in length, is eight or nine inches.

Having examined the top and the bottom, it remains to look at the ſides of the ſtone. They are very irregular, but they afford more and more inſight into its nature. The firſt thing that occurred to me in this examination, was an appearance as it were of little ſtreams, or a repreſentation of brooks running in an undulated courſe through the body of the ſtone, not from top to bottom, but from end to end.

The whole ſurface of the ſtone is of a pale brown colour, but theſe are paler than the reſt: they are of the breadth of a man's finger, more or leſs, and they are compoſed each of a number of lines as if drawn by a tool. This is their appearance at firſt ſight, but afterwards I found them to be ſo many cruſts of matter lying one over another. There are generally two, ſometimes three of theſe ſtreams in a ſtone of eight inches thick, and they lie near the lower ſurface. They are not carried ſtrait on, but riſe and fall in a ſort of irregular ſpherical forms repreſenting ſo many arches. This I perceived afterwards to be owing to their conforming themſelves to thoſe riſings and hollows that were in the ſtone. The upper ſurface alſo conforms itſelf in the ſame manner, though it break into many parts; and it appears upon the whole, that all depends on thoſe hollows which I have mentioned in the under ſurface.

Between theſe rivers as it were of cruſted matter, there are maſſes or beds of the common ſubſtance of the ſtone, and over them a much larger bed or maſs of it continuing to the top, of which the curdled ſurface ſeems only a covering.

CHAPTER the THIRD.

Of the inſide of the Cotham *Stone.*

I Have now deſcribed, as well as I am able, the outſide of one of theſe *Cotham* ſtones: and I doubt not but there will appear in it ſomething very ſingular, as well as very beautiful to the curious reader. But that is nothing to what the ſtone affords.

I was curious to know the inner ſtructure and appearance of a ſtone whoſe outſide ſhewed ſuch extreme ſingularity: I ſpoke to a perſon whom I ſaw there to procure me a hammer, that I might break one of them to ſee what was within. He anſwered me, that it was pity to break the ſtones, but if I pleaſed he would ſhew me what they were on the inſide.

He then brought me one of them cut through the middle lengthwiſe, and poliſhed upon the ſurface made by the cutting. Heavens! what was my ſurprize. What beauty, what variety! We ſend abroad for ſtones, and purchaſe them for ornaments at a great price, and do not know that we have what are vaſtly ſuperior at home.

The poliſhed ſurface afforded a landſcape that appeared the work of ſome maſterly hand in painting. There appeared rivers, foreſts, mountains, grotto's, and every thing that could be conceived to embelliſh a fine picture. In one place ſpecks of a dark colour, and irregular form, reſembled clouds ſeen through ſome diſtant opening; in another place is the greateſt token of an open country; and in others, trees, buſhes, ſhrubs and hedges, with brooks and rivers running among them.

The ground colour of the ſtone is a duſky brown, but this is raiſed in the ſeveral parts, not the ſame throughout. At the very bottom there is generally a coat paler than all the reſt, and at the top, where the rough riſings are cut through, it is paler than in any other part, except this at the bottom. The reſt is ſhaded with different degrees of brown; and the figures which are neither raiſed nor ſunk in, but ſtand upon a level with the reſt, are ſome of them blackiſh; and the very paleſt of them are of a darker colour than the reſt of the ſtone.

It is found, that in whatever part the ſtone is cut in the ſame direction, the ſame figures appear, ſo that ſlabs may be cut out of it, a great number from each ſtone; it cuts eaſily, and takes a tolerable poliſh. The gentlemen of the neighbourhood are not altogether unacquainted with its beauty. They frequently have it cut into ſlabs and poliſhed to put in frames, in which it has a moſt elegant appearance. We have been uſed to value what is called *Florentine* ſlate for the repreſentation of ruins, and ſuch like figures, that are naturally in it; but that is not at all comparable to the *Cotham* ſtone. This is as much ſuperior as marble to free-ſtone.

I ſhall give, as well as I can, a deſcription of the poliſhed face of one of theſe ſtones which I received as a preſent from a gentleman, and which I brought up with me, for by this a competent knowledge may be had of the reſt, as they are all very much alike.

The bottom is a little hollowed, and the top, in a correſpondent manner, raiſed into arches. The rough matter, which is paler than the reſt, is about half an inch thick; and the hollows which are under theſe arches, are deeply ſhaded with black.

From theſe there hang in all parts irregular ſtreamers, ſtrait or winding, and rough on their ſurface, reſembling briers or ſtalks of honey-ſuckles hanging from the roofs of the caverns. Theſe are many of them two inches in length, and they hang down amidſt a deep brown matter which makes that part of the ſtone.

At about an inch below the bottoms of theſe, there runs one of thoſe ſtreams of darker matter reſembling a canal or river. This is a third of an inch broad. From the ſurface of this there riſe a kind of ſhrubs and buſhes in a row, very irregular, but very pretty. They ſeem to grow along the ſides of the canal, and are tall enough for their tops to reach toward the bottoms of the hanging branches. Above theſe alſo, or in the maſs along which the laſt named appearances deſcend, there are little clumps of black ſpots reſembling the ſhrubs upon ſome heath.

Below the ſtream juſt mentioned, there is a bed of the common matter of the ſtone of about an inch deep, and at the bottom of this runs another river, broader than the firſt, and of a deeper colour: and from the ſurface of this, as if growing on the banks, riſe another row of trees, the talleſt, moſt regular, and moſt beautiful of all. Below this undermoſt river is a plate of a kind of ſpar, gloſſy and elegant; and under this is the loweſt or paleſt coat of the ſtone.

Would any one ſuppoſe, that there was in our own country a ſtone of ſuch beauty, and in ſuch plenty; and that among the number who have written on theſe products of nature, no one ſhould have named it. I doubt not, but from this diſcription, it will come, as it deſerves, into reputation.

CHAPTER the FOURTH.

Of the ſubſtance, nature, and origin of the Cotham *Stone.*

I Have obſerved that the *Cotham* ſtone is not very hard, and that in the lower part it has the appearance of clay more than of any thing ſtoney. The whole has indeed the appearance of a hardened clay; and beyond doubt is no other: but it is ſo hardened, that it has at this time a very fair title to the name of ſtone, and it poliſhes in the manner of one.

I mentioned a vein of ſpar running flatwiſe of the ſtone under the loweſt river and in the ſame courſe. This ſeems to have been introduced ſince the original formation of the ſtone, and to have filled up ſome crack or crevice in it.

I am to add, that on the poliſhed ſurface there appear alſo in this ſtone eight or ten other cracks, of which three are larger than the reſt. It would have created confuſion to have named theſe in the preceding chapter, when treating of the figures that were upon the ſurface, nor are they very conſpicuous. But it is proper to mention them here, and they will be found to give no little light into the formation and nature of the ſtone.

As the firſt mentioned broad cracks ran flatwiſe of the ſtone, theſe run perpendicular, or from top to bottom; and they do not terminate at the flat one, but are carried through it quite to the bottom of the ſtone.

The greateſt part of theſe can only be ſeen as ſtreaks upon the ſurface of the ſtone, having no breadth; but the three or four principal ones have been wider. They are of the thickneſs of a ſmall pin, and are all broadeſt toward the bottom, and narrower toward the top; and they are filled up in the ſame manner with the large ones before named, with a pure and glittering ſpar of a greyiſh colour.

I have obſerved already, that the bottom of the ſtone was formed into ſeveral hollows,

lows, which in this ſection have ſomewhat the figure of arches; and the largeſt of theſe cracks riſe from the ſpaces between two of theſe arches, or they riſe one on each ſide of each arch; and are continued, but not exactly, ſtrait up to the ſurface, where they always terminate in the ſame manner on the two ſides of ſome of the upper arches, or of the riſings whoſe hollows form the grotto's before mentioned. Theſe cracks, if nicely ſearched after, may be ſeen on the ſurface alſo of the ſtone, paſſing through the appearances of rivers, and continuing their courſe to the ſurface.

From theſe, from the ſubſtance and nature of the ſtone itſelf, and from the compoſition of its ſeveral parts, it may be poſſible to form ſome reaſonable conjecture as to its origin. From this we ſhall ſee to how trifling cauſes are owing thoſe beauties we ſo admire in the fineſt ſtones; for probably the veins in agates, and the trees and moſſes in *Mocha* ſtones, are owing to no better cauſe.

I ſhall not take upon me to ſay at what time theſe ſtones were formed; but I think it is not difficult to ſay of what materials they are compoſed, and in what manner they were put together and acquired their form.

In the firſt place, the ſubſtance was originally clay; and this muſt have been mixed up in water; for the whole form of the ſtone ſhews it was formed by ſubſidence. This water muſt have contained ſtoney matter, for I have abundantly proved already, that all water does contain it, and this mixing with the clay, has given it the hardneſs of ſtone.

Well then: here is a quantity of clay, with ſtoney matter among it, held up in water, and ready to ſink down. A certain quantity does ſink, and forms a cake of two feet broad, and half an inch thick, and this ſpreads itſelf evenly upon the bottom, let that be what it will. This makes the bottom part of the ſtone, which is more clayey than any other; and this ſeems in ſome caſes to have ſettled all at once, and in others at a great many times; for in ſome it is one entire ſubſtance, and in others 'tis compoſed of a multitude of cruſts.

This falls flat at firſt: and if it continued ſo, a great part of the beauty of the ſtone would be loſt; but it does not: this flat cake, which is ſoft, and not very heavy, becauſe not very thick, has impriſoned ſome air underneath it; this air raiſes it up into a kind of blebs or bladders, as we ſee the mud in ditches, where it is more rarified, or is endeavouring to eſcape. The matter hardens in this elevated condition, and thus are formed the rudiments of the ſtone, thoſe arches which we ſee in the bottom, and which never loſe themſelves afterwards.

Having laid the foundation of the ſtone, the following it up to its whole perfection will be eaſy, and will be done upon the ſame principles. The remaining clay being longer held up in the water, gets more of the ſtoney matter mixed with it, and therefore it becomes harder, and of a deeper colour.

By degrees it ſinks. Firſt of all there falls upon this ground-work or loweſt layer of the ſtone, which is now elevated on the top, and full of hollows below, a great number of thin coats of the mixt matter one after another. Theſe ſettling upon the cake, conform themſelves to its ſurface, that is, they riſe and fall, more or leſs, with the riſings and ſinkings of the ſurface. As theſe go over the ſeveral elevations, they all together form that repreſentation which has been called the loweſt river: and there being ſome foul blackiſh matter (probably a lighter earth) in the water at the ſame time, this ſinks with them, and diverſifies the appearance as it is ſeen among them.

There is now formed the firſt bed, and the loweſt river. Upon theſe there has been ſunk a thick cake at once, or a large quantity of the mixt matter. This has formed the bed of ſtoney matter that is between the two rivers.

There has been alſo among this, as among the other, ſome lighter and finer blackiſh earth mixed with the water out of which the matter ſubſided: this has therefore fallen down with it; but air being alſo impriſoned here, though in leſs quantity, has tried to eſcape, and riſing upwards from the bottom of this bed, in ſeveral ſtreams, it has carried up this blackiſh matter with it. Sometimes this has reached the ſurface of this bed, and ſometimes the air has eſcaped, leaving this behind. Wherever it has come, it has formed theſe reſemblances of trees and buſhes, which ſeem to grow from the ſurface of the river, that is, which ariſe from the bottom of the preſent bed ſpread over the top of the laſt which formed the loweſt river; or, as the black matter has been carried higher, theſe repreſentations are taller.

We have now the loweſt cake of the ſtone, the loweſt river, and the firſt broad bed of ſtone all accounted for, and the figures in them. The reſt will follow on the ſame principle, and fewer words will explain it.

Upon this bed lies the ſecond river. That is, upon the ſurface of this quantity of the ſtone, have ſettled, from time to time, freſh quantities of matter, with ſome of the ſame black matter among them. Theſe quantities have been ſmall, and thus have been formed the ſecond river exactly as the firſt.

Over this has fallen a larger quantity, and there has been formed by this another bed, but ſmaller, exactly as over the firſt river, and there riſe the appearances of ſhrubs from it, owing to the riſing of the air bubbles as in the firſt.

Upon this has ſettled another bed of matter in which the black earth has formed a quantity of irregular repreſentations of clouds; and over this the cruſt, which is not of the colour of the reſt, but pale in the manner of the bottom or loweſt cake. This riſes in arches, as the whole ſubſtance of the ſtone has more or leſs done, from the original figure of the loweſt cake. Theſe arches, which are filled up with the laſt bed of matter riſing into them, are variouſly formed; and, to the figure of the upper ſurfaces of theſe, is owing the beautiful ruſtick of the natural ſurface of the ſtone.

Thus have I traced, with a bold, but I hope not a raſh hand, the courſe of nature in the formation of this ſtone from the beginning to the end. The account was neceſſarily minute, becauſe it required to be circumſtantial: but however ſingular it may appear, this ſtone, which we have ſo nicely examined, is ſtill in being, and there will need no more than looking carefully over it, to confirm every part of the relation.

There remains only to enquire into the nature of thoſe cracks which are ſo frequent in the ſtone, in order to underſtand with eaſe every thing that regards the ſingularity and beauty of its ſurface: the archwork and riſings, and all the variety of figures, being owing in a great degree to them.

I have obſerved already, that the principal of theſe cracks terminate at the interſtices between the principal riſings; and in the ſame manner there are, in ſome part or other of the ſtone, cracks larger or ſmaller to be diſcovered, which lead to the interſtices between all the reſt; it is plain therefore, that theſe have greatly aſſiſted in forming of them.

That theſe riſings on the ſurface of the *Cotham* ſtone, in ſome degree depend upon thoſe of the lower plate or bed, I have already obſerved; and the form of the whole ſtone, as viewed on the poliſhed ſurface, and much more as examined on the rough ſides, ſhews it. Theſe however would only account for the principal riſings, and in the whole they are almoſt innumerable. The cracks explain the reſt; let us examine them.

We have ſeen a maſs of matter, ſoft and of a mixt nature between clay and ſtone, formed by the ſubſidence of that mixt matter from water. It is therefore ſoft when it is firſt formed, and it is to dry afterwards; the water, out of which it was dropp'd, at a certain time leaving it.

Now let us ſee how this happens in things that are every day familiarly before us; if a lump of tough clay be thrown out of the pit, and left to dry, it cracks in the drying in a great many places. Why ſhould we doubt but that the ſame thing muſt happen to this ſtone: without a doubt it muſt, and there is proof it did.

Theſe cracks happen at random in the rude clay; but the raiſed and depreſſed parts of the maſs in this ſtone determined naturally the courſe of the principal of them; and theſe run, as reaſon tells us they muſt, from the interſtices between the raiſed parts irregularly upwards. To theſe were owing then the great riſings of the ſurface of the ſtone, for it muſt riſe between them; and, from the firſt cauſe, the unevenneſs of the bottom cake had began to do ſo.

Theſe cracks were not all that happened in the maſs, though theſe were the principal, for as we ſee in the clay, ſo it would be evidently in the ſtone, beſide the large, there would be ſmaller. Theſe running irregularly to the ſurface, have given origin to the reſt of the configuration: and thus, in part, to theſe cracks, and in part to the riſings of the firſt plate, are owing all theſe beautiful riſings of the ſurface.

There remains only to account for the filling up of theſe cracks, and the referring the ſtone to the kind to which it belongs, to cloſe this ſingular account.

That the cracks which are formed in the drying of a piece of clay, do not fill up again, is no wonder, for clay is an uniform ſubſtance. But this is not the caſe in theſe ſtones. The ſame cracks happen in them as in the clay, and they are compoſed of two ſubſtances, a clay, and a ſtoney matter, which is ſpar. Water continually paſſing through the clay, leaves it as it was; but water paſſing through the ſparry ſtone, diſlodges the fineſt part of the ſpar, and leaves it in the cracks, juſt as the ſame ſubſtance is left in the crevices of ſtone.

In this there is nothing ſtrange, nothing but what is in the courſe of nature every where before us; and we may be the more aſſured that we judge right in this, becauſe we ſuppoſe her to act conformably to her univerſal cuſtom.

But I hinted that it would remain to refer this *Cotham* ſtone to that kind to which it belongs; and this may be done by means of theſe cracks, and that very plainly and certainly.

In the clay pits every where about *London*, and I believe I may ſay in moſt places in *England*, there are found, in great quantities, maſſes of a matter which ſeem an hardened clay. They are not ſo hard nor ſo fine in their grain as the *Cotham* ſtone, but otherwiſe they are like it. Theſe have all had cracks in them, which doubtleſs have been formed by the ſhrinking of their matter in drying, and theſe cracks are filled up with ſpar. This ſpar is of a yellowiſh colour, like bees-wax, and from this, as it is diſpoſed in the courſe of theſe cracks as it were in veins, the ſtone being called the *waxen vein.*

It is true that the *Cotham* ſtone is of a finer grain than theſe, and the ſpar which fills up its cracks is not yellow as in theſe, but bright and whitiſh, but ſtill the nature of the ſtone is the ſame; and notwithſtanding its fineneſs, and the beauty of its trees and ramify'd figures, I ſhall not ſcruple to ſay it is of that kind.

CHAPTER the FIFTH.

Concerning the ſtones called Snake Stones.

THE gentlemen in this part of the country are not without curioſity. I have mentioned already that I ſaw in their houſes plates of the *Cotham* ſtone poliſhed and ſet in frames for its beauty: in ſome places I alſo found what are called ſnake ſtones, preſerved for their ſingularity.

It was with theſe as with the *Cotham* ſtones, I ſaw them ſingly at firſt, but afterwards I had opportunities of examining them in quantities together; and in their natural place; and this I would recommend to be done, if poſſible, by all who wiſh to account rightly for the things they ſpeak of.

Theſe ſnake ſtones are flat ſtones of different bigneſſes, ſome are a foot round and others above a yard. They are a kind of free-ſtone in ſubſtance, and of a whitiſh colour; and they look not unlike the *Bath* free ſtone when it is dry.

They have each of them the repreſentation of a ſnake, in raiſed work, upon their ſurface, ſo that the reaſon of the name is obvious; and there is enough of ſingularity about them to attract any one's obſervation. The ſnake is always repreſented upon them as rolled or coiled up, the tail being in the centre, and the largeſt part at the other extremity. They are rolled ſo cloſe, that there is none of the ſtone ſeen between them; and they are generally marked with croſs lines, in ſuch manner, that they ſeem ribbed, or like the body of a ſnake, when the ſkin is taken off.

There never is any head to theſe, or any thing that has the leaſt appearance of a head naturally: the country people ſometimes carve one upon the ſtone with a knife, but this is a fooliſh piece of impoſition. It is impoſſible there ſhould be any ſuch thing as a head upon the natural ſtones, becauſe the thing is not a ſerpent that is repreſented upon them, although it have enough reſemblance of one to juſtify the name.

I had ſeen theſe with ſurprize and pleaſure at ſeveral gentlemens houſes; but at length, going between *Bath* and *Keynſham*, I found the place where they lay in the earth; and, from the circumſtances of this, I ſhould have been naturally led to think otherwiſe of their origin, than to have any notion of ſnakes upon them, even if I could have fallen at firſt into ſuch an opinion.

Theſe ſtones lie at different depths in the earth, and in the ſame places with them, there are always found oyſter ſhells, cockle ſhells, and many other ſhells of ſea fiſhes, which very naturally lead one to judge properly about the origin of theſe figures of ſnakes.

We find in different parts of the earth the remains of what have once been animals living in the ſea. I am told that the bones and teeth of ſea fiſhes are frequently found. But to ſpeak only of what I know, there is at *Catſgrove-Hill* near *Reading* in *Berkſhire*, about two hundred yards from the river *Kennett*, and upwards of forty miles from the neareſt part of the ſea, a large bed of clay of divers colours, and between that and a large bed of chalk that lies under it, there is found a bed of whole oyſters and oyſter ſhells, intermixed with ſea ſand, ſome very large and entire, and others very much broke and decayed. Part of this bed of oyſters and ſea ſand lies forty feet deep in the earth, but no part of it ſeems to be more than ſix or eight inches in thickneſs.

And there are ſhells, of many ſorts, quite perfect and entire, often found in the hardeſt maſſes of ſtone which riſe in exceeding high hills; but they are generally by the ſides of rivers that have a communication with the ſea.

It is a very ſingular obſervation, and many have referred their coming to theſe places, and being ſunk in the bodies of ſtone, to the changes that were wrought upon the earth at the time of *Noah*'s flood. Perhaps a great many of them may be as old as that time: but we know that changes happen in the earth ſo frequently, that a great many may have come by their preſent ſituation otherwiſe.

We know that the ſea has in many places deſerted the ſhores, and rivers have changed their courſe in the ſame manner. Now the clay which was at the bottom of theſe places may have hardened ſince that time into ſtone, and the ſhells which lay upon it, when it was at the bottom, may have been forced into it by other earth by ſome accident falling over it, and turned to ſtone with it.

That theſe things may eaſily happen, and certainly do often happen, from various cauſes, I am firmly of opinion. I have often obſerved the fine ſoft mud, thrown out of the *New River* near *Iſlington* in the ſummer time, to be full of ſhells of a dark blueiſh colour, ſome very large; and when the mud was dry, I have many times broke it, and found very large muſcle ſhells in the inſide of it. This mud has the appearance of ſeveral of the clays about *Briſtol*: and was it of that hardening nature with the mud or clay of ſome of the ditches and lanes leading towards *King-Road*, which being thrown up in heaps by the road-ſide, turns to a hard ſolid maſs like ſtone, the ſhells in this mud of the *New River*, would exactly reſemble thoſe we find in the inſide of the hardeſt ſtone, ſome of them being very nearly of the ſame ſize, ſhape and colour.

This entirely convinces me, that thoſe hard maſſes of lime-ſtone, which are of ſo fine and cloſe a grain, and in the inſide of which theſe ſhells are found entire, an inſtance of which I have brought up with me, muſt, at the time they ſunk into them, have been, as they certainly were, ſomething of the ſame nature with that fine ſoft mud of the *New River*, and afterwards turned to ſtone, as is natural about *Briſtol*; neither do I think it poſſible to account for ſhells coming into thoſe ſtones ſo well any other way.

Theſe changes therefore may eaſily be conceived to happen from the obſervations already laid down; reaſon tells us they may happen, and experience convinces us they do. The ſeveral ſea ſhells that are petrified, ſo far as I have ſeen, are moſtly lodged in the ground near to the ſea ſhores, or at leaſt where floods might have carried them, or elſe about the banks of rivers that have a communication with the ſea.

Theſe therefore may have been thrown up and turned to ſtone by common accidents and in the general courſe of things. As to thoſe which are ſaid to be found in inland countries, and on tops of mountains, they require another explication. I ſuppoſe there are ſuch found, elſe they would not be ſo punctually ſpoken of, and if they are, I don't ſee that any thing leſs than *Noah*'s flood can account for them.

In this caſe they are teſtimonies of a thing, which, if it had come from any mouth but that of God himſelf, would not have been believed without ſuch teſtimonies. In this however we ſee the divine wiſdom, as in other caſes, leaving none without conviction. There may be thoſe who will not regard the ſcriptures, and there may be thoſe who cannot have opportunities of ſeeing them, to ſuch theſe proofs, of ſo great an event, ſpeak without them; and it muſt be found by reaſon that ſomething great was the cauſe of it.

But let us return to our ſubject, perhaps I am as much out of my ſphere talking as a divine, as like a phyſician or a philoſopher. I was ſaying that the place in which theſe *Keynſham* ſnake ſtones are found, and the things that are found along with them, ſhew that they are not ſnakes which we ſee upon the ſtones, but are much more likely to be a repreſentation or remain of ſome ſea ſhell.

In the firſt place I ſhall obſerve, that if any ſuppoſe them to be the natural marks and features of the ſtone, and that thoſe ſtones now lie in their proper beds, where they had their formation and growth, ſuch err greatly. Stones that are buried in the earth, and are in their natural ſtate, have their features ſtrong and bold and freſh, and look in all parts healthy, but theſe do not. I ſhall call for an inſtance the *Cotham* ſtone. Now the ſurface of this ſtone, which is curdled into a ſort of ruſtick work, is hard

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and fair and healthy, and ſo would the repreſentations of theſe ſnakes if they were the natural features of the ſtone, and the ſtone were in health; but inſtead of that, they are faint and worn out more or leſs, and defaced ſo that there is no appearance of the ſtone being in a healthy ſtate.

It is plain from this, that ſome accident has befallen them; and that the repreſentation of a ſnake has been added by accident, is the moſt likely, for it does not ſeem in a ſtate of health or growth. This would convince me, that it was not a natural part of the ſtone, had I no other proof of it: but there are many more.

We are to find therefore what it is that gives this figure. The vulgar ſay a ſnake, but it is only the vulgar. It is true, there are found impreſſions and figures of fiſhes upon ſtones, but then they are water animals, which ſnakes are not, and the water animals are thoſe moſt naturally found on ſtones in the earth.

We ſee this figure of a ſnake among figures of ſhells, and theſe belong to real ſhells. They are ſhells petrified. What then is ſo natural as to ſuppoſe, that this is alſo a ſhell petrified? It will be anſwered, that there is no ſuch ſhell. But who knows that? there may be thouſands of ſhells in the ſea that we know nothing of; for we do not go to the bottom, but only find a few that are about the ſhores.

But they will ſay we know the others: it is a miſtake. It is very natural to call a little ſhell fiſh, that is as big as my thumb end, and is ribbed all the way down, a cockle; but if we examine theſe that we ſo freely call cockles ſtrictly, we ſhall find that they are no more cockles than they are oyſters or muſcles; though they very much reſemble cockles: they are particular ſorts of ſhell fiſh that we know nothing of, only as we ſee them in the ſtone; and why ſhould we wonder that the great one is unknown to us, when the little ones are the ſame.

Upon the whole, there is all the reaſon in the world to believe, that this repreſentation of a ſnake rolled up, is really a petrifaction of a ſhell, which being ſo beautiful in this condition, muſt be much more ſo if ever we ſhould ſee it living. This however is to be confeſſed, that although ſomething ſhelly is to be found about moſt other petrified ſhells, there is nothing of this, not the leaſt appearance in the world in the ſnakey figures upon the *Keynſham* ſtones that I have ſeen.

The ſame figures of ſnakes are found in other ſtones, and at different places; and I have heard, that about ſome of them, there is a ſhelly matter found. I only ſpeak of what I know and have ſeen, and I would not go beyond truth to favour my own opinion.

CHAPTER the SIXTH.

Concerning the petrifying and encruſting power of the Earth about Briſtol.

HAVING mentioned the ſea ſhells which are found petrified or turned into ſtone in this country, it may not be improper to enquire into the manner in which this change is brought about. It is a very ſtrange one; but it is very frequent both here and elſewhere. But it may be explained very clearly upon the principles that have been eſtabliſhed in theſe obſervations.

We ſhould ſuppoſe it natural perhaps, that a ſhell, buried by any accident in the ground, ſhould rot and fall to pieces in time, as they really do at *Catſgrove-Hill* near *Reading*, and in other places. But let us examine why we think they ſhould do ſo every where. The earth is always damp, and moiſture has this power of decaying things. That is to ſay, water has that power. Water may have ſuch a power above ground; but we find, by almoſt all the obſervations in the preceding part of this book, that water ſeldom has ſuch power under the earth, juſt on the contrary we find water ſo full of ſtoney matter, and ſo ready in part to turn into ſtone, that it fills every crack and crevice of the moſt ſolid rocks with ſtone of the moſt pure kind, cryſtal or elſe ſpar; and therefore, if we extend the obſervation, we ſhall find petrifying things, in ſuch a country, to be a very natural conſequence.

Water we ſuppoſe is to make a ſhell, or any other ſubſtance which it finds in the earth, decay: but how do we ſuppoſe it is to do this? by penetrating into its pores, and diſuniting its particles: very well. But this water is full of ſtoney matter; and being, as we find, ready to leave this matter behind it, in every crack or crevice that it finds, in form of ſtone, why ſhould it not leave it in theſe pores? It doubtleſs does. The ſhelly matter may by degrees decay and be waſhed away, but this ſtoney part of the water is left in its place. This is continued to be done till the whole ſhell is diſſolved and waſhed away, and ſtone left in the place of every particle of it, and what is this but petrifaction.

Thus we ſee how eaſily ſo ſtrange a change may be brought about when we underſtand only the nature of common water, and of its effects upon things under ground. And it is very poſſible, that in ſome places, this may be favoured by the nature of the ſoil.

This I ſhall endeavour to prove not only to be poſſible in ſome places, but to be actually the caſe in the country about *Briſtol.* And to this perhaps I ſhall be able to prove is owing tne particular face and ſtate of that country.

If water contains a great quantity of ſtoney matter, than water is able, in ſome ſlow way, and in the courſe of nature, to diſſolve this ſtoney matter, though we cannot make it do ſo in any of our operations. If water can diſſolve ſtoney matter, water may take it out of one place in the earth and carry it to another. Perhaps it will be hereafter proved, that it abſolutely does ſo, and then we ſhall find a new way of accounting for all theſe appearances which ſurprize us ſo much about *Briſtol.*

It will perhaps appear, that the original power of encruſting and petrifying lies in the earths and clays themſelves, a thing few have thought upon; and that the water only ſerves as a vehicle, as they call it, to carry the ſtoney matter out of one place into another. This is plainly the caſe here, and I ſuppoſe elſewhere.

As to the petrifaction of ſea ſhells that have lain in the earth any time in this country, it is not at all ſtrange, for nothing can be put into it here that will not undergo the ſame change. Thus if pieces of coal, of cinders, or of touchwood be thrown into a new opened bed of earth or clay in this part of the country, and covered up again, they will, in time, be petrified or at leaſt encruſted; of all which I have brought up inſtances. In the touchwood it is an abſolute and proper petrifaction, ſo far as it goes, for the water having penetrated its ſubſtance, has left ſtoney matter within. In the two other inſtances, the effect is rather incruſtation; the coal being only covered in part with ſtoney matter on its ſurface, and the cynder about thoſe cavities into which the wet could find way without entring into its ſubſtance, theſe being much finer and cloſer in their texture than the touchwood, and conſequently not admitting the water into their pores ſo readily.

Now the ſtoney matter lodged by the water in the pores, and over the ſurfaces of theſe bodies, might be originally in the water itſelf, muſt be allowed, for a little ſerves this purpoſe: but there are other occaſions on which much more is required, and for theſe it muſt be firſt taken up out of the clays and earths; and that this may be done, and is done continually, is certain. Nay, the obſervation will take place farther than is conceived, only let us firſt ſee the ſtate of the fact, and then reaſon.

In whatever part of the country about *Briſtol* we examine a piece of pure and unmixed hardened clay, of whatever kind or colour, or from whatever bed, we ſee in it a vaſt quantity of bright whitiſh and glittering particles. Theſe are no part of the clay itſelf, for they are altogether different from its ſubſtance, neither are they found in clay in other places, although they are univerſal in it here.

When theſe little glittering particles are examined ſeparately, they are found to be for the moſt part ſtoney, and of the nature of cryſtal or ſpar. There are ſome others among them, ſuch as flakes of a ſtuff like iſinglaſs in ſome places, and little glittering pieces of mundick in others, but the generality are of this ſtoney, cryſtalline or ſparry nature.

Now if we examine alſo the ſtones and rocks of this part of the country, we find them in the ſame manner full of glittering particles. In this they agree with the earths, and in this they differ from the ſtones in many other places.

All this being taken together, does it not ſeem natural to ſuppoſe, that not only the petrified ſubſtances found in the earth in theſe places, but even the beds of ſtone themſelves, owe their origin to theſe particles contained in the earth, and to the agency of water, which can diſſolve and remove, diſperſe, ſeparate and gather them together again in various forms and combinations.

If water can diſſolve theſe particles of ſtoney matter; water can in the ſame manner keep them ſuſpended a time: and let them gradually ſeparate and congeal afterwards. Water therefore can, when it is thus loaded with them, act as a cement or agglutinating liquor to fix things together, or to introduce changes in them. For inſtance, water can fill the pores of clay; and if water that is thus full of ſtoney matter, do fill the pores of a bed of this earth, and afterwards draining gently away, do leave that ſtoney matter behind, why it does in that caſe cement that bed of clay into a bed of ſtone.

And the thing ſeems plain that it does ſo, from the appearance of almoſt all the beds of the ſofter ſorts of ſtone that are opened round *Briſtol.* Moſt of them reſemble clay at a diſtance, like the bottom of the *Cotham* ſtone, but of different colours; neither would any one, who does not know them to be ſtone, take them to be any thing elſe but clay, if he did not ſee the diviſions of the joints.

This may ſeem a new doctrine to ſome, and it will be, I doubt not, oppoſed by others. Thoſe who have not conſidered theſe things themſelves, will be ſurprized to hear of a bed of earth being by any accident turned to a bed of ſtone: and thoſe who have imbibed the opinion that all things remain at this time as they were ſettled after the deluge, will oppoſe it with all the vehemence of contrary opinion; but for this I am altogether eaſy. It matters not to me how theſe things appear to ſuch as are prejudiced. I ſet down what I take to be facts, and I doubt not but that they will appear ſuch. If I have in any part reaſoned wrong about them, I ſhall be glad to be ſet right.

If this be allowed to be the ſtate of nature, it will not appear wonderful that the country about *Briſtol* ſhould be more full of rocks and ſtones than moſt other parts of this kingdom.

We ſee the beds of clay abound with ſtoney particulars in this part of the kingdom; and we find according to this ſyſtem which I have ventured, as I think from purſuing nature in her courſe, to eſtabliſh, that the water which is continually falling upon the ſurface of the earth in rain, and ſoaking through theſe beds of earth and clay, is able to diſſolve theſe little ſtoney particles, and to carry them to other places. Now may not it ſometimes happen, that the water which has carried this ſtoney matter diſſolved out of one bed of earth, may be ſoaked up by another whoſe pores are ſo formed that they will receive and detain this matter; and in this caſe, will not the lower bed of earth, by degrees, in a ſucceſſion of time, and by repeated operations of this kind, be cemented into a bed of ſtone or rock? It appears to me that the caſe can be no other.

Nay farther, if it happen that the clay itſelf in which theſe ſhining and ſtoney particles are lodged, ſhould be of ſuch a texture that its pores might be capable of receiving and detaining in every part a quantity of ſtoney matter properly introduced into them, may it not happen, that the very water draining into this bed of earth or clay from the ſurface, and detained in it by its own cloſe nature, may, after it has diſſolved theſe ſmall particles of ſtoney matter, which ſhine and glitter in ſeparate parts of the clay, depoſit them in much ſmaller particles all over its bed; and in this caſe, may not the very bed of earth itſelf, containing theſe ſtoney particles, be converted into a ſolid rock or bed of ſtone by the agency of the water.

For my own part, I know not what a bed of ſtone is, if it be not a bed of earth firmly united and impregnated with ſtoney matter, or in proper words, a bed of earth petrified. For the operation appears to me to be juſt the ſame in lodging a quantity of ſtone in the pores of earth and in the ſhell of a cockle.

While the ſtoney matter lodged in a bed of earth is ſcattered about it in particles diſtinct and ſeparate from the earth itſelf, it cannot be of any effect in giving ſtrength and firmneſs and conſiſtence to the earth; although there be enough of it, as to quantity, to convert the whole bed into ſtone; but in this caſe, if we ſuppoſe water let in upon it to diſſolve theſe particles, and then, when it has diſſolved them, if we ſuppoſe it detained till it has again left them united with every the leaſt portion of that earth, ſuppoſing them at firſt agreed to be ſufficient in quantity for converting the whole into ſtone, I do not ſee what can be the conſequence, except it be the converting the whole ſo into ſtone, or making it one bed of rock.

That this is frequently done all about this country I make no doubt; and this is a very plain reaſon why, as I obſerved before, there ſhould be more rocks here than any where elſe perhaps in the kingdom.

CHAPTER the SEVENTH.

On the Rough Stones of Clifton-Hill.

I Have ventured to ſpeak of the formation of ſtone at this time as a thing very frequent; and I have made water the great agent in bringing about that little imagined effect: but all that I have hitherto obſerved upon that head, ſtands only on the footing of conjecture. It regards what is ſuppoſed to paſs in the bowels of the earth; at leaſt ſo far under its ſurface as to be out of our reach of ſeeing, and the time allotted to it, is alſo too long for our obſervation.

But what is there delivered only on conjecture, I ſhall in this chapter prove as certainty. I ſhall ſhew in what manner ſomething of that kind is done at this time, and is tranſacted under the inſpection of our ſenſes. What I ſhall here produce is done upon the ſurface of the earth; in the moſt publick places, and in the openeſt manner;

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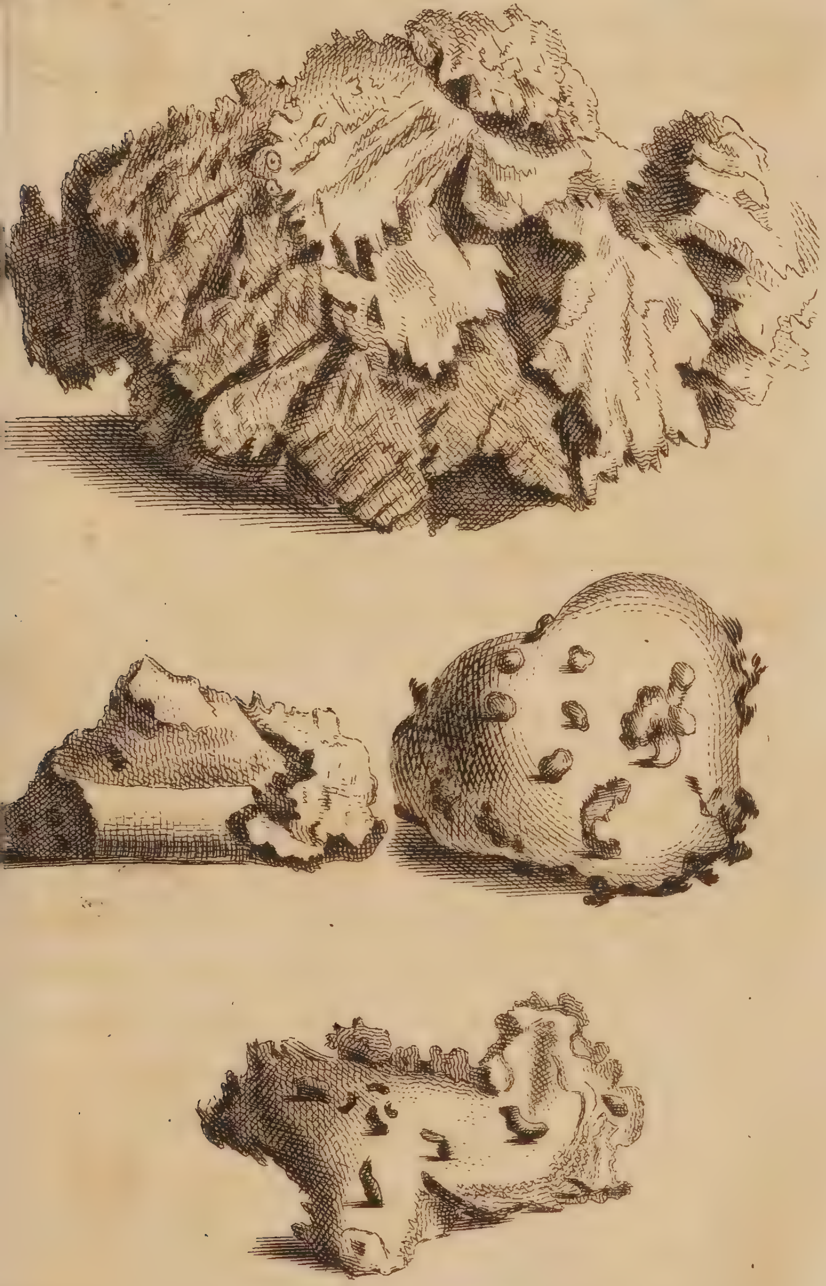

The Rough Stones on Clifton Hill

and alſo, I imagine, in a little ſpace of time.

One part of this work depends upon another, and therefore I would have none condemn a part till they have ſeen the whole; what is advanced in one part upon conjecture, is often confirmed in another from experience; and though it might be eaſy to cavil at opinions, there is no diſputing facts.

In the laſt chapter, I have ſuppoſed that water has a power of diſſolving ſtoney matter, and afterwards depoſiting it again in ſuch a manner between the particles of other bodies, that it ſerves as a kind of cement uniting them together. This is all I have required to the proving that whole rocks of ſtone may be at this time formed out of that which was not ſtone before; and that water has this diſſolving power, and can act in this double capacity of a diſſolver and a cement, I ſhall now ſhew beyond the poſſibility of a miſtake, or a doubt.

I have taken notice already, that in this country there is no ſuch thing as pebbles, or any other ſmall ſtones of that kind, however common they may be in others. There are ſome ſtones of a roundiſh form, and of various other ſhapes, and ſome of them might look at firſt ſight like thoſe pebbles which are ſo common about *Hampſtead* and *Highgate*, but, upon examination, they will be found to be only pieces of lime-ſtone, or fragments of the rocks. With theſe fragments the roads are mended, and they ſerve the purpoſe extremely well.

This is the caſe of *Clifton* hill, the publick road is mended with theſe ſtones, and there uſually lie many of them about the ſides of it. Thoſe fragments of lime-ſtone which are laid in the road, are, by the carriage wheels, after a time, broken to pieces, and in part ground to powder. This powder, when rain falls upon it, is reduced to mud; and we ſhall ſee what is the conſequence.

The water in this mixture with the powdered ſtone does all that I have ſuppoſed it poſſible it might do in the former caſe. It diſſolves a part of it; and, at a proper time, and under proper circumſtances, it blends that diſſolved part in ſuch manner among the reſt of the mud, that it cements it into ſtone again. Nor is this all its power in that capacity as a cement: for it actually fixes the ſtone ſo made upon others in the moſt ſtrong manner.

If this can be proved, I ſuppoſe it will be allowed me very freely, that water in the earth may do the ſame thing; and that it may convert mud of another kind, as well as this, into ſtone: for it may convey enough of the ſtoney particles among it. This muſt be allowed, if the other be proved, and that ſhall be done preſently.

We find the duſt made by grinding the lime-ſtone under carriage wheels upon *Clifton-Hill* to be made into mud by water; what do we ſuppoſe ſhould be the conſequence? Why, let us mix any other powder with water which it will not diſſolve, and we ſhall find it will be duſt again as ſoon as the water is dry'd away. If I ſhould be aſked, whether this be not the caſe of the mud in the road of *Clifton-Hill*, I ſhall confeſs it is ; and that is, becauſe the continual paſſage of other carriages prevents its natural congelation.

But there is another circumſtance I ſhall obſerve, under which we ſee the experiment try'd in a fairer manner. We know that to all the productions of nature, time and reſt are required. If the field were to be harrowed over every day after it was ſown, the wheat would never grow up in its regular ranks ; and the caſe is juſt the ſame with reſpect to that mud of the road ſides here, which is continually rubbed, and ground and broken again by the feet of cattle and the wheels of carriages : but if there be any ſtate in which we can ſee it in compoſure, there we are to look for the effects which nature regularly would produce.

This we exactly ſee in the caſe of that part of this mud which is thrown upon the ſtones that lie, as I obſerved before, upon the ſides of the road. It has here time to dry without being diſturbed, and we here ſee the proper and natural effect.

Every ſpeck of dirt, as well as every larger parcel of it, that is thrown againſt or upon one of theſe ſtones on the road-ſide, becomes itſelf a ſtone, covering the other in part or wholly, or adhering to it on a ſmaller part of its ſurface.

This is the exact caſe, and there is no arguing againſt ſo plain a fact. This is a proof that ſtone may be formed at this time by the agency of water which has paſſed through places where it has diſſolved ſtoney particles. For that it has abſolutely diſſolved ſome of the particles of this ſtone is evident; and that it acts as a cement, on that principle: lodging that diſſolved ſtone where it reſts.

The mud or dirt of theſe roads, being a mixture of ſtone and earth ground to powder, becomes a maſs of ſtone upon its being well mixt with water and ſuffered to dry. Earth and ſtoney matter therefore may, by the agency of water, be made into a ſtone or rock, if the quantity be ſufficient: and this is all I have deſired toward the accounting, my own way, for the vaſt quantities of rocks that there are in the country all about *Briſtol.*

But I ſhall purſue this obſervation farther, for there is a great deal more to be offered, which will tend to anſwer any poſſible objections, and farther to illuſtrate the matter itſelf. That the thing is fact I have taken care there ſhall never want proof. Some ſtones, covered with this mud turned into ſtone, I have brought up with me: and as it was poſſible the numerous inſtances of it, that I ſaw on the ſides of the road, might be employed to mend the way again, or, by ſome other accident, removed or deſtroyed, I have left ſeveral of them with Mr. *Dean* who keeps the turnpike leading from *Clifton* to *Durdham-Down*, where any who go that way may ſee them.

But to prove that the water which diſſolves the ſtoney matter in theſe inſtances, is afterwards in a capacity to act as a cement, I ſhall only need refer to the ſeveral pieces of theſe ſtones which I have brought to *London.* If the water ſerved only as a liquor to mix the whole into a paſte, and that the particles of ſtone were of themſelves ready to concrete into a maſs as ſoon as they were ſo brought together, which is what ſome may chance to think, then the maſſes of mud which had been thrown againſt the ſtones on the road-ſide, would only harden into ſtone, but they would not ſtick or adhere to the other; whereas the truth of the matter is, that theſe new-made ſtones do adhere to the old ones in the moſt perfect manner that can poſſibly be conceived; and the place of their adheſion to them, is as firm as any other part of their ſubſtance. Theſe ſtones, which lie upon the road-ſides, to which the others grow, and upon which we find them converted from the mud into their own nature, are of the lime-ſtone kind. They are, like all the other ſtones of this place, fragments of the rocks; but then they are ſuch as have got themſelves a covering or coat. Now this coat is different in colour from the body of the ſtone, and is ſpread equally all over it. How this is brought about, has been ſhewn already; 'tis only neceſſary to repeat ſo much that it may be remembered every one of theſe ſtones has ſuch a coat, and that it is diſtinguiſhed eaſily from the matter of the ſtone by its colour. This will give us the means of knowing how exceedingly different the proceſs of nature, in the forming of the new ſtones from the mud thrown upon the old ones, is from the bare drying of that matter.

I will begin with the leaſt inſtances, and go on to the greateſt; and, in this account, I will mention nothing but what is to be ſeen on the ſtones I have brought with me: and which, with the *Cotham* ſtone, and the chips or fragments of rocks that have obtained new coats or coverings, may be view'd by all who pleaſe, at *Sam*'s coffee-houſe in *Ludgate-Street*, where they will be left ſome ſhort time for that purpoſe.

When a ſtone has lain at a diſtance from the road, the large quantities of the mud cannot reach to it, and only thoſe ſmall quantities thrown up by the ſplaſhing of a horſe's feet that goes haſtily, or ſome ſuch occaſion, can get at it. In this caſe we ſee the ſtone covered at little diſtances with little parcels of the mud as they have been thrown upon it; and theſe, according to the quantity of the mud, and to the conſiſtance of it, lie in ſmaller or larger, and in higher or flatter pieces, ſome of the bigneſs of half a pea, and ſome of hazel nuts; and they are in various irregular forms, as chance has directed the matter.

We ſee the ſtones lying upon the road-ſides with theſe ſpots upon them, and we ſuppoſe them to be mud freſh thrown on. They look no otherwiſe than as ſtones by one of our common roads, ſplaſhed with the common mud, but, upon taking them up, we find theſe ſpecks of ſuppoſed mud, to be real ſtone, as hard as the body of the ſtone on which they lie, but of a darker colour. That they have been mud once is certain, but they are now ſtone: and their being of a duſkier colour, and, in ſome inſtances, for it is ſo in ſome, of a coarſer texture, is owing to this, that there was ſome earth or dirt mixed with the mud, which has debaſed the ſtone.

Theſe adhere ſo firmly to the body of the larger ſtone, that there requires the face of an hammer to break them off; and when they are thus broken off, a new wonder appears. They are always found to have eaten away, as it were, the ſubſtance of the coat. And though they doubtleſs fell upon ſuch a coat, as it is ſpread every where over the ſtones, yet they adhere to the abſolute body of the ſtone, the coat being in this part conſumed, or elſe converted into the nature of the reſt of the matter: and the ſtone, new made out of the mud, in all things reſembling the other, except it chances, according to the accident before mentioned, to be ſomething of a coarſer grain.

In ſome places, by the road-ſide, one meets with ſmall ſtones, of this kind, over which a large quantity of mud has been thrown at once. This has ſettled round them while moiſt, and hardening afterward, we find it lying upon them in the form of a broad belt or circle of ſtone. Theſe make a ſingular appearance, the whole ſeems as if it had been a work of art, as if for ſome reaſon a workman had ſurrounded the ſtone with a quantity of mortar that had in time grown hard, and intended it for ſome particular uſe in building.

But theſe, and a thouſand other accidental things of the ſame kind, are trifles in compariſon of the large and compleat pieces and coverings of new ſtone which we ſee attached to, or ſpread over thoſe larger lumps of ſtone that have chanced to lie near the road. Theſe receive much more of the mud, and they retain it in a greater perfection.

I have obſerved, that the new made ſtone, which is found upon the ſmaller lumps of old ſtone, is generally coarſer than the original ſtone. The obſervation is almoſt univerſal, but it is not ſo with reſpect to thoſe quantities of the mud which fall upon larger ſtones, and in larger portions together. Many of theſe, which lie upon the hills where there is but little dirt to mix with the powdered ſtone, are, in all reſpects, equal to the ſtone itſelf; but there are others, eſpecially in lower places, where there is a great deal of duſt and dirt, where the new made ſtone upon them is very foul, and you muſt break two or three inches into the mud, before you can plainly diſcern it to be ſtone, although the whole quantity of mud upon them is very hard.

It muſt be confeſſed, that two things, very ſingular, offer themſelves to the obſervation in reſpect of theſe ſtoney maſſes formed by the concreting of the mud made of other ſtones: the firſt is, that the ſmalleſt quantities, and thoſe which fall on the ſmalleſt ſtones, are the coarſeſt; and the ſecond is, that of the new ſtone not adhering to the coat of the old one, but mixing itſelf with its very ſubſtance. Theſe I take to be both owing to the ſame cauſe. The pureſt mud thrown thus upon the ſtones is not only of the ſame nature with itſelf throughout, but 'tis of the ſame nature with thoſe ſtones alſo, for it is formed of the ſame, ground to powder. The laws of attraction therefore doubtleſs act here, and occaſion what we ſee. I believe, if the thing had been named to Sir *Iſaac Newton*, he would have ſaid all this muſt be, without ſeeing it. The largeſt quantities of the mud muſt concrete more firmly and uniformly than the ſmaller, from this principle; and as they concrete more firmly, the grain will be finer: and the ſame thing will explain all the reſt. For right reaſon always agrees with fact.

But to return to the mention of thoſe ſtones, which being large, and lying near the road, have received larger quantities of pure mud: we find theſe covered with great cakes of new made ſtone. I have brought ſome with me, on which the cake is half an inch thick, or more, in ſome places; and is abſolute ſtone, the ſame with that upon which it is fixed. It is not only perfect ſtone like the other, but is healthy and ſtrong in every reſpect, and has got a coat over it as natural and fair as the other.

Theſe are the pieces which ſhew the new made ſtone in its greateſt perfection. They are as hard and ſtrong as the common lime-ſtone of the natural rocks; they have the ſame ſound when ſtruck with an hammer; they are full of the ſame glittering particles; they alſo burn into ſtrong lime; and, to all appearance, they are full as heavy, though there is no judging exactly of ſtone here by its weight, even if ground to powder, and a meaſure full of it afterwards weighed, all ſtones weighing heavier or lighter according to the health and ſtrength of the rocks they are taken from, thoſe taken from healthy rocks being all very heavy, and thoſe from decayed ones, very light.

One may diſtinguiſh in theſe large maſſes, more than in the ſmaller, when the mud has been thrown on thick, and when thin. For in the firſt caſe, the new ſtone ſtands up in a bold lump; in the other it is ſpread flatter, and has the ſurface more ſunk, in ſome places, according to the ſurface of the ſtone to which it adheres. But even the largeſt ſtone I have brought up, is but a very ſmall one in compariſon to many I had of the ſame kind, ſome of which weighed upwards of half a hundred weight a piece, with lumps of new ſtone upon them of three or four inches thick; and others, that weighed about four or five pounds a piece, quite ſunk in mud, their ſurface being only to be ſeen where the mud had not cloſed. I broke off and brought to town one piece of this mud, and it is a perfect, ſtrong and healthy ſtone. But the ſtones themſelves were too big to bring to *London*.

I know not how plain I have made this in the writing, but nothing can be ſo evident in fact. If any one has a mind to be convinced, he need only examine the ſtones themſelves for certainty.

OBSERVATIONS

On the EARTHS, ROCKS, STONES, and MINERALS, about *Briſtol*, &c.

BOOK the SIXTH.

Containing obſervations on the adjoining parts of *Glouceſterſhire* and *Somerſetſhire*.

CHAPTER the FIRST.

Of the Stone and other Contents of the Earth and their Uſes.

AS I have now ſet down what I took notice of as moſt worth obſervation, about *Clifton*, the Hot-well, and other places near *Briſtol*; I ſhall deliver, with the ſame plainneſs and freedom, what I remarked in that part of the ſame country into which, during my reſidence at *Clifton*, I made excurſions. And I ſhall be glad if any thing I have to ſay may prove curious or uſeful.

The face of the country, for a conſiderable diſtance round about *Briſtol*, whether we regard *Glouceſterſhire* or *Somerſetſhire*, is very mountainous, and the hills are full of large beds of ſtone of one or other kind. They are of various colours, ſome very hard, others very ſoft, and ſeveral are prettily marbled; ſome have a very fine grain, and others are very coarſe and porous. At St. *Michael's-Hill* near *Briſtol*, there is a bed of ſtone ſo ſoft that they will cut you out a piece in any form or ſhape you pleaſe. It is ſomething of the nature of the *Bath* free-ſtone, and like that too hardens in the air. It is of a much finer grain, but is not of ſo good a colour; however it makes very good lime, being, when dry, a cloſe, firm, ſolid ſtone.

This continues to be the caſe for thirty or forty miles, except *King's-Wood*, the earth whereof, and ſome few other places, is full of pure coal; and after this, eſpecially towards *London*, although ſome of the hills are very high, they conſiſt chiefly of chalk.

This is of various degrees of hardneſs, ſome being little firmer than dry clay, and other beds of it nearly as hard as ſome ſorts of ſtone: it is the chalk of this laſt kind which is called in ſome places chinck, that makes the beſt chalk lime; the ſofter chalk yielding a lime though white, yet weak and unfit for many purpoſes.

I find it is a rule, that all ſtones which will make *aqua fortis* hiſs and riſe up in bubbles when it is dropt upon them, will burn into lime: and chalk has this effect more than any.

The beds of this chalk are often of a prodigious thickneſs, and in ſome the whole quantity ſeems to make but one vaſt maſs; in others I find it is divided, like the limeſtone rocks, into a kind of joints; and the ſides and tops of theſe have often a great many beautiful figures drawn upon them in black, repreſenting moſs, and ſhrubs, and the like.

Theſe figures, in ſome degree, reſemble thoſe in the *Cotham* ſtone, as to their make, but they are very different in their ſituation and nature. Thoſe upon the chalk are only on the ſurface, and decay: they ſeem little more than as figures made upon a white cieling with the ſmoke of a candle, and they may eaſily be rubbed off. The ſame are ſeen in the chalk pits about the *Thames* ſide by *Greenhithe* and elſewhere; but, on the contrary, the figures in the *Cotham* ſtone lie deep in the body of it, and are not effaced but rendered more plain by poliſhing.

Among this chalk alſo there are found vaſt quantities of flints. They are of various ſhapes and ſizes, from two or three ounces, to twenty pounds weight. Some are round like a cannon ball; others irregular, oblong and ragged; and ſome not unlike branches of coral.

Theſe are chiefly of the deep black flint kind, and they have a fine coat of white. Indeed I hardly know any ſtone, that, in its healthy ſtate, has not ſome coat or other.

But even theſe hard flints, eſpecially the ſmaller ſort, and ſuch as always lay wet in the ground, in time go off, decay, loſe their fine bright gloſſy colour, and look quite dull and rotten. Great quantities of theſe are dug up and laid in heaps on the roads to mend the ways.

Moſt of the hills at a diſtance on each ſide the road between *Briſtol* and *Bath*, and ſo on toward *Marlborough*, whether we take the road to *Chippenham*, or go by the way of *Sandy-Lane*, afford ſtones of very different kinds and ſhapes from thoſe about *Clifton*. Theſe do not riſe in joints like the lime-ſtone rocks on *Durdham* and *Leigh-Downs*, but in flat pieces, from half an Inch to a foot in thickneſs, and from a foot ſquare to ſuch as are ſix or ſeven feet long, and three or four feet broad.

Theſe have all of them thin coats or coverings while they are in a healthful ſtate. Many of them are very hard, and ſome are beautifully marbled with different colours. Theſe ſtones have for the moſt part glittering particles in them when freſh broken and expoſed to the ſun; but, in the moſt favourable examination, they are not in this reſpect equal to thoſe about *Clifton* and other places nearer *Briſtol.* We alſo ſee in the crevices and hollows of ſome few of them, ſome ſmall effects of that cryſtallizing or encruſting power which abounds ſo much in and about all the quarries of ſtone and beds of ore upon the mount adjoining to *Clifton.*

Theſe ſtones are employ'd for various purpoſes. The largeſt and faireſt of them ſeem formed by nature for tomb ſtones and monuments, and they are uſed throughout the country for that purpoſe. The better ſort of the ſmall ones are employed in pavements of all kinds, and in building of ſmall houſes; and the reſt ſerve for building of walls for encloſing of yards, fields, and gardens, which they do very dexterouſly by laying them looſe one upon another, without mortar or any other cement whatſoever.

The fragments and ruder pieces of all the harder ſorts of theſe ſtones ſerve for mending the roads, and they do it excellently, the road from *Briſtol* to *Bath* is proof of this. It uſed to be one of the worſt in *England*, but they have mended it with theſe ſtones, and it is now a very ſound and good road.

CHAPTER the SECOND.

Concerning the Bath *Stone.*

SOME may have wondered, that in treating of the rocks and quarries of this country, I had not before mentioned the *Bath* free-ſtone, as it is a very conſiderable thing: but being exceedingly different from all the reſt, I reſerved it for a diſtinct chapter.

The hills near *Bath* afford this ſtone, and it riſes in prodigious maſſes. This ſtone, like the lime-ſtone rocks of *Durdham* and *Leigh-Downs*, does not run in a continued bed, but is divided into natural diſtinct pieces, which they call joints. Theſe however are of different ſizes, and ſome of them very large, being perhaps from one or two hundred, to fifteen or twenty tons each joint.

Vaſt as ſome of theſe maſſes are, and diſtinct as nature keeps them, they are diſpoſed in their beds with great irregularity. Some of the layers of them being upright, and others lying flatwiſe. As it lies at a great depth, and is often raiſed in very heavy pieces, they have ſome trouble in managing it: but as the pits are very large and open, and they make uſe of particular ſorts of cranes of great ſtrength for the pulling it up, it is done with much leſs fatigue than any one could expect.

There is no ſtone that differs ſo much in its bed, and after it has been wrought and expoſed to the air, as the *Bath* free-ſtone. While it is in the ground, it is ſoft, moiſt, yellowiſh, and almoſt crumbly; and it ſeems very little more than congealed ſand, and that not well concreted together. But when it has been ſome time expoſed to the air, and is thoroughly dry'd, it becomes white, hard, firm, and an excellent ſtone. It is much more porous than the lime-ſtone kinds, and has fewer of the glittering particles.

The cryſtallizing or encruſting power is no where more viſible than among the joints, and in the few cavities of this ſtone. For whatever water gets into ſuch cavities, congeals to a ſort of very dull ſtones, of the ſame form and ſhape of the bright cryſtals of *Clifton*; and whatever gets between the joints, lodges upon the tops, or runs down their ſides, turns to a dull ſort of ſpar like white biſcuit or whitiſh ſugar; and, if there be a large crack in the ſide of the ſtone, that ſhall be filled with ſpar to a great thickneſs, and then it looks like congealed honey. This dull cryſtal and ſpar are alſo, like thoſe at *Clifton*, produced without the leaſt aſſiſtance of the ſprings; no water whatſoever, that riſes from the ſprings, coming any where near them. They are all produced from rain water, and that only. But I do not find that any of the ſtones about *Bath* or *Briſtol* retain this cryſtallizing or encruſting quality, or that water has any ſuch effect upon them, when they are removed to any diſtant part.

The new ſquare at *Bath*, which is a very beautiful piece of workmanſhip, is built of this ſtone. By this may be ſeen how fit it is for that purpoſe. It has certainly a noble look in all large open places; but I am afraid, if it were to be uſed in narrow ſtreets, where the ſoot and ſmoke is beat down in damp weather, it would, on account of its being ſo very porous, ſoon look very black, dirty and naſty.

This ſtone is however excellent for the fronts of houſes, and for working into many ſorts of ornaments for gardens, *&c.* as it cuts freely with the chiſſel, and gives way to the fineſt tool; and yet it is afterwards ſufficiently firm, and of a fine colour: but it is too rough, coarſe grain'd, full of ſand and porous to burn into lime.

This *Bath* free-ſtone does not appear ſtrong and healthy above the ſurface of the earth, like the rocks upon *Durdham* and *Leigh-Downs*; on the contrary, they are obliged to dig fifteen or ſixteen feet deep before they come at the firm joints. For the firſt three or four feet they find only what they call rubble or rubbiſh, and for about twelve feet more, they only meet with a coarſer ſtone in ſmall and ill-ſhap'd maſſes. This they employ in coarſer works and in laying foundations; but the large and fine ſtone is a thing quite diſtinct from it.

The method in which they carry this ſtone down the hill is alſo very ſingular, and the contrivance very ingenious: it well deſerves a particular notice. The road is made with grooves, and the carriages are long and low. They are made very ſtrong and of wood; and they have four low hollow wheels, made of iron, all equal in height.

Only one man manages this machine, and he keeps behind. His principal buſineſs is to guide it, to attend to its going at a proper ſpeed, and to lock the wheels when it goes too faſt. The heavier theſe carriages are loaded, the faſter they go. But the uſual quantity of ſtone they lay on them, is about three tons at a time.

CHAPTER the THIRD.

Concerning the ſtones called Grey Wethers on Marlborough-Downs.

I Propoſed in this concluding part of my work, to take notice of ſome things of the ſame nature with thoſe named in the reſt of the book, but at a greater diſtance from the place where I have made the obſervations: the mention of theſe ſtones is an inſtance of it.

Theſe grey wethers upon *Marlborough-Downs* are indeed an amazing ſight. At a diſtance they have the appearance of flocks of ſheep lying down in different places. As we come up to them, we find them to be all diſtinct ſtones, many lying very near, and others at a diſtance from one another. On examining them, I found them in a ſtrong and healthy condition, like the tops of the rocks on *Durdham* and *Leigh-Downs.*

Far from having ſuſtained any damage from the air, they have each its coat or cruſt like the healthy lime-ſtone rocks already mentioned, and are perfectly ſtrong and ſound within.

The coats of theſe ſtones are all of a greyiſh colour, one only excepted, this is white, and looks at a diſtance like a heap of ſnow: they are of irregular figures, many of the ſhape of pebbles; and they are of all ſizes, ſome prodigiouſly large, and others but ſmall.

When I ſpoke with the People of the place concerning the ſingularity of ſuch large maſſes of ſtone lying in ſo particular a manner, they gave it me as their opinion, that they took their riſe in the different places where I ſaw them lie, and the tops of numbers of them, juſt ſhooting as it were healthy and ſtrong out of the earth, as if they belonged to large maſſes growing up within it, ſeemed to confirm them in that opinion; but be that as it will, the oldeſt and moſt ſenſible part of the people aſſured me, it was their ſtedfaſt belief, that they had grown very conſiderably in their time.

But whether they took their riſe there or not, I ſhall not take upon me to determine: I ſhall only mention the ſtate of their appearance, and of certain things about them at preſent, and leave the concluſion to the reader, who is as able as myſelf to make it.

At firſt indeed I thought no farmers would ever ſuffer ſo much good land to have been loſt as they cover, but that they would certainly have removed them whilſt ſmall, had they took their riſe there; and therefore I concluded they muſt have been brought there to build a place of ſtrength, or ſome place of publick worſhip; and the viſible remains of a very large old *Roman* cauſeway, built with the ſame kind of ſtone, being very near many of them, ſeemed to convince me I was right in my opinion.

But on the other hand, when I took a larger view of the things themſelves, when I ſaw many hundreds of them lying together in different places, and others lying ſcattered about, ſome ſingly, others in ſmall numbers together, and all very irregularly over the country for ſix or eight miles round, I was ready to doubt the firſt conjecture.

On examining theſe, ſome are found to lie bedded deeply in the ground, reſting upon the top of the natural beds of chalk, which, with a great number of ſmall, and ſome large flints, is the common produce of this part of the country; others juſt appear out of the ground; ſome lie almoſt upon the ſurface; and others, but theſe are fewer, ſtand upright on their ends, and are eight or ten feet in height.

Upon this examination we are convinced that they are not the produce of any other place: and when we ſee ſome of them fifteen or twenty tons weight each, lying upon hills, and can find no ſtone of the ſame kind any where in the country nearer than that of which the famous *Stone-henge* is compoſed upon *Saliſbury* plain, I became ready to quit the opinion that they were brought thither to ſerve for the works I had before ſuppoſed them got together to build; and, as for the old cauſeway, I imagine it to have been built of them, becauſe they were neareſt at hand, and upon the ſpot.

CHAPTER the FOURTH.

On the nature of the Stone of which the Grey Wethers are compoſed, and its uſes.

I Have already obſerved, that theſe ſtones are ſound and in a good condition, and that they are covered with their proper and natural coats: this, together with the great improbability of their having been brought from elſewhere, from their ſize, and the height of the ground where many of them lie, will, I believe, be apt to turn the opinion

nion in favour of their being natives of the place, though of this I determine nothing. It remains to enquire into their nature: in this reſpect they are not all alike, for ſome of them are hard and firm, and others ſoft and porous, ſucking up water like a ſpunge.

Their general colour when freſh broken, is whitiſh or greyiſh, though ſome are of other colours, and they have ſome glittering particles in them, but theſe are few, and not at all comparable to thoſe in the ſtones about *Clifton*.

We ſee nothing of that cryſtallizing or encruſting effect about theſe ſtones that is ſo univerſal among thoſe near *Briſtol*. In thoſe parts, not a drop of water enters the cracks or crevices of the rocks or beds of ore, or even falls upon the ſtones themſelves, but it leaves ſomewhat of a cruſt, or ſome looſe cryſtal or ſpar behind it. But here, whatever water falls upon the ſtones, either runs off, or gets into the holes upon the ſurfaces of them, of which there are great numbers, ſome very large, and is either dried up by the ſun, or ſoakes into the ſtones themſelves, and no appearance of cryſtal or ſpar of any kind whatſoever is left behind; neither does any encruſting matter at all appear in any of their cracks or crevices. The holes upon the ſurfaces of theſe ſtones were doubtleſs occaſioned by the lodging of water upon them in a long courſe of years; and though ſome of them are very deep, the coats all round their ſides, and even at bottom, appear quite healthy and ſtrong. A conſiderable number of theſe ſtones have of late years been drilled and blown to pieces with gunpowder, and uſed in building walls and paving and mending the highways. But this way of working with gunpowder comes dear; and the additional expence of breaking them ſmall afterwards, and the carriage, all put together, make it leſs worth while than it at firſt appeared: notwithſtanding which, they are ſtill often uſed for the beforementioned purpoſes, eſpecially when they happen to lie near the place where the work is to be done.

They at one time uſed theſe ſtones in building houſes and cottages, but the walls were ſo damp in wet weather, that few people choſe to live in them; ſo this is entirely left off at preſent.

CHAPTER the LAST.

Containing ſome few farther remarks on a part of Wiltſhire.

ONE of the moſt obſervable things I ſaw in this part of *Wiltſhire*, which is a fine open hilly country, with a ſoil that equally anſwers to the plow and in paſturage, except the grey wethers, is *Marlborough-Mount.* It is indeed a very amazing and beautiful piece of workmanſhip: the aſcent and deſcent are ſo eaſy in going round it, that a perſon ſcarcely regards whether he is going up or down all the way.

There is alſo another mount which is greatly aſtoniſhing in its aſpect and ſtructure. This is called *Silver-Hill*, and is four miles from the other toward *Bath*.

The form of this is that of a ſugar-loaf, but it is flat at the top like *Marlborough-Mount*: it is ſomething higher than all the hills thereabouts, and affords an extenſive and fine proſpect.

At ſome diſtance all about this, there are ſcattered many leſſer hills called *Barrows.* All theſe are ſuppoſed by many to be funeral monuments.

The *Silver-Hill* itſelf is ſaid to have been erected to one of our antient kings who fell in battle; and the leſſer ones that are about it, are ſaid to be thoſe of his principal officers, who had behaved gallantly, and fell with him.

THE

CONCLUSION.

THUS have I put together the thoughts and obſervations which occurred to me during ſome leiſure months that I ſpent in this pleaſant and healthful country. I ſhall be glad if they be found uſeful, or but entertaining to thoſe who are of a thinking turn. But of this my friends (at whoſe deſire they are publiſhed) may be aſſured, that whatever is ſet down in them, is, to the beſt of my judgment, truth.

FINIS.